JUL 22 1918
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SPECIAL SCIENCE NUMBER

Volume IX
Number 4

APRIL, 1918

$3.00 a Year
50c Per Copy

The Journal of Educational Psychology

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PUBLISHED MONTHLY, EXCEPT JULY AND AUGUST BY
WARWICK & YORK, INC.,
HERSHEY, PA. BALTIMORE, MD.

[Entered as second-class matter at the post-office at Hershey, Pa., under the Act of March 3, 1879.]

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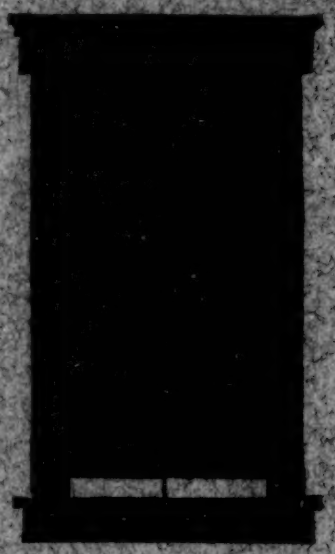

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VOLUME IX APRIL, 1918 NUMBER 4

THE JOURNAL OF
EDUCATIONAL PSYCHOLOGY

AN EXPERIMENTAL STUDY OF METHODS IN TEACHING HIGH SCHOOL CHEMISTRY

WILLIAM H. WILEY

Miami University, Oxford, Ohio

No field of secondary education presents more numerous or more important problems than the teaching of the sciences. The age is a scientific one. The applications of science are advancing by leaps and bounds. Yet the teaching of science in the high school is not having the influence on our boys and girls that it should. In the field of chemistry in particular no experimental studies have been made either on subject matter or on methods of teaching. In a recent article Professor E. B. Spear[1] points out many of the unanswered problems that face the chemistry teacher in teaching the simplest things. He inquires what would be the correct amount of time to spend on chemistry and how should this time be distributed. Is a pupil justified in taking one year of chemistry and then stopping? In the process of learning chemistry, involving, as it does, manipulation, observation, correlation of ideas, logical memory, imagination and reasoning, there are many problems from which Spear suggests the following. How can we best promote dexterity in the manipulation of apparatus? Does observation gained in chemistry increase accuracy of observation in the ordinary circumstances of life? Should careful directions be given to the student for observation, or should he be free to observe what he will? Should pupils correlate facts with facts, theories with theories or facts and theory? Should the instruction be largely a correlation of facts, theories and principles? Should the experiments be chosen of simply to illustrate a point or to correlate the new facts with those previously learned? What is the best way to teach relationships? In logical reasoning should we insist upon the student holding to

[1]E. B. SPEAR. *Problems in the Experimental Pedagogy of Chemistry.* Journal of Educational Psychology, Vol. 6: 1915, 231–241.

conclusions limited to the data at hand or generalizing beyond these data? How are we to teach the pupil to test his premises? Should the student know before-hand the purpose of his experiment or should the results determine the purpose? Is not the pupil often prejudiced by the purpose? Should chemistry present constructive problems to train the imagination? Would it be of any value to have the pupils predict what they would expect from an experiment? Is it better to have pupils construct apparatus from meager descriptions or to give them full directions and sketches? Spear thinks that these problems belong to the field of experimental pedagogy, and that their solution would greatly enhance the effectiveness of chemistry teaching.

There are many other problems in the teaching of chemistry. We ought to know what material is the best for beginning pupils, the kind and amount that can be taught effectively in the high school course of one year. We ought to know whether the training obtained in a high school course justifies itself, or whether we ought to spend the time teaching valuable facts. No matter how we look at the question of high school chemistry there is one point that we must consider. The learning of facts is one of the important functions of chemistry teaching. Whether the pupil is to form habits, to observe, or to reason, memory plays a most significant part. The learning of fundamental facts and principles seems to be the first problem for consideration.

This investigation will, therefore, attempt to apply the methods of experimental pedagogy to the problem of teaching certain facts in chemistry. *The main problem* of this study is to determine the best of three methods of teaching chemistry, the text-book recitation method, the so-called lecture method, and the laboratory method. By the best method we mean that which gives the best results in the least possible time and with the least expenditure of energy. The results are then to be determined qualitatively and quantitatively as well as their effect upon the student.

By the *text-book method* we mean the study of the book on the part of the pupil without apparatus or other helps. After the pupil has studied the lesson he recited it to the teacher according to the latter's questioning.

By the *lecture method* is meant the teaching of the lesson by alternately talking and questioning the pupils concerning a topic they have not previously prepared. In this method apparatus and

other helps are used and the pupils' attention is centered upon the demonstration performed by the teacher. This is commonly called the informal lecture.

By the *laboratory method* the pupils are given a problem and directions as to its solution. They are given the necessary apparatus and materials and allowed to work. While they are working, the teacher continually questions them to keep the problem before them. They may write notes, but this is not required for these experiments. Learning here means both immediate and permanent retention of the facts imparted in the lesson. As far as these tests go we must limit our measure of retention to one month after the test or lesson is taught.

Secondary Problems: (1) The investigation of permanent retention as well as immediate recall. (2) The study of sex differences in learning chemistry. (3) The study of individual differences in learning chemistry. (4) The effect of the different methods on the pupil, in regard to interest, attention and fatigue. The criterion for judging these problems will be the pupils' efficiency in responding to written tests.

The Tests

For the preliminary tests a number of lessons were used, some selected from text books and others written by the author. The most important of these was "The Chemistry of the Parlor Match." The final tests consisted of three lessons written by the author. The problems for the lessons were as follows:

Lesson I. What makes things burn?
Lesson II. Why is baking powder used in cake?
Lesson III. How is cloth colored?

Each lesson was so written as to contain the important ideas about each problem named. The lessons were of practically the same length and of the same difficulty in so far as this could be determined by a preliminary test. Each lesson was typewritten on uniform paper 8½″ x 11″ and each student had a copy. As far as possible the papers were uniform in size, difficulty and value of ideas.

In the laboratory method each pupil was supplied with all the necessary materials and apparatus to work out the problem. In the lecture method I used apparatus in teaching each of the lessons and drew the facts from their observation. Additional facts I told them, until they had all the ideas in the lesson.

The Subjects

The subjects for these experiments were 24 pupils in the McGuffy High School of Miami University. They were in the junior and senior years of high school and all had studied physics. They were probably a little above the average high school pupil in intelligence owing to their environment and training. They ranged in age from 16 to 20. None of the pupils had studied chemistry and none of the work was familiar to them. In grouping the students for the tests it was necessary to use their physics marks as a partial criterion. These with a set of preliminary marks were averaged and on this basis the 24 pupils were divided into three groups of eight each. Each group was assumed to have the same average ability in so far as marks form a measure of ability. The pupils were taught in groups of eight each and tested immediately after the lesson. The groups were again tested one week after the lesson and again four weeks after the lesson. The tests were in writing and were given under uniform conditions as far as these could be controlled.

Preliminary Tests

A number of preliminary tests were given in order to determine the advisability of using certain methods of procedure in these tests. Thus a lesson was selected from a book on chemistry and the pupils told to study it until they knew it. They were asked to record the time required to learn it. Other tests were written out in the form of laboratory directions and pupils were asked to carry out these in the laboratory. They were then asked a number of questions to which they were to write out the answers. The unsatisfactory results of these experiments led the writer to control the entire lesson as well as the tests, for it was found impractical to depend upon the student to carry out the directions.

A second set of preliminary examinations was given to determine the relative value of the lessons to be taught and secondly to determine the average ability of the class. For the first test five students were selected who had no knowledge of chemistry. Copies of each lesson were given the group and they were told to read the lesson carefully once. They were then given paper and told to write all they could remember of the lesson. On the succeeding day at the same time they followed the same procedure with lesson two. On the next day they did lesson three. The papers were collected and carefully graded.

Now in order to determine roughly the ability of the members of the class another lesson (The Chemistry of the Parlor Match) was presented to the class. Each member was given a sheet of the printed lesson. I carefully read the sheet to them, and then told them to read it carefully once and as soon as they finished to turn over the paper. They were then asked to write out on a sheet of paper all they could remember of the lesson. These papers were collected and carefully graded.

Final Tests

1. Plan of the Tests.

Each of the three lessons were typewritten on paper 8½" x 11" and each pupil was provided with a copy of each lesson. The lessons and tests were all given at the same hour, at 10:45 A. M. on Tuesday, Thursday and Friday of each week. In so far as the conditions of environment and teaching were controllable they were made uniform.

The Text-Book Recitation Lesson

In this lesson the pupils were each given a copy of the lesson and were told to study it carefully until they felt they knew it. Anything not understood was explained. When the majority stated that they knew it, all copies were laid down and I asked various questions concerning the lesson. In this way I covered the important points in the lesson. I also answered any questions they asked about it. The time was recorded. I now passed paper and asked them to write out a complete resume of the lesson. These papers were collected ,and graded. One week later the same class were given paper and asked to write out the lesson they had had last week. Nothing was said at the first test that there would be a further test. Likewise nothing was said of the third test, which was given like the others at the end of four weeks. All papers were graded according to the method described below.

The Lecture Method

In this lesson the materials and apparatus were arranged on the table before me. I presented a problem to the class, *e. g.* "What makes things burn?" and informally discussed the material on one of the typewritten sheets. I talked most of the time but occasionally asked a question which I thought they could answer. While talking and telling them about burning, oxygen and so on, I performed the experiment to illustrate the subject matter on the sheet

of lesson II. I wrote new and difficult words on the blackboard and at the end summarized the important points in the lesson. I then gave them paper and asked them to write out all they remembered of what I said. I collected and graded the test papers. A second and a third test were given one week and four weeks later, just as described in the lesson above.

The Laboratory Method

In this method the pupils were taken into a laboratory and each assigned a definite place. They were then given a problem and a sheet containing the directions for the lesson. They were told to read the lesson and in the meantime I placed the necessary material on the desk. As I passed the materials I asked them what they needed and as they told me I gave it to them. They then went to work and performed the experiment. I stood by and watched each student carefully to see if he knew what he was about. I continually asked questions of different members of the class to be sure that the main points of the lesson were being established. When they concluded the experimenting I had some of them summarize the points of the lesson and show me how they had solved their problem. I then passed paper and told them to write out the lesson as they remembered it. A week and a month later I had them write out the lesson again without any preparation in the meantime. They had no idea of the second and third tests and this removed any incentive to look up the lesson in the meantime. All the tests were collected and graded as follows.

2. Method of Scoring.

Each of the three lessons was carefully analyzed by Professor Whitcomb (Head of the Chemistry department, Miami University) and myself, and the lessons were divided into a definite number of important ideas and a second group of unimportant or amplifying ideas. The former were given two credits each and the latter were given one credit each. The lessons were then revised so that the value of all the credits in each lesson should total 40. The distribution of these credits for each lesson was as follows:

	Lesson I.	Lesson II.	Lesson III.
2 credits	13—26	14—28	13—26
1 credit	14—14	12—12	14—14
Total	40	40	40

In correcting the papers full value was given for the idea correctly stated, half credit for partly correct and no credit if missing. If an incorrect idea was stated for the correct idea one credit was deducted from the total. Ideas not in the original lesson were not credited.

RESULTS

The following tables give the numerical results of the preliminary tests.

a. Preliminary Tests to Determine Ability

GM –73	MC –46	GC –66	FC –50	SG –64	EB –46
HT –56	OR –40	RC –53	GS –53	HF –63	CM –56
FB –46	ES –33	EB –46	TS –46	FK –60	DS –43
SH –60	HS –46	LR –53	HF –33	NP –50	BK –31

Average Physics Grades of the Above Students

GM –88	GC –94	SG –86
HT –84	RC –90	HF –85
FB –90	EB –85	FK –80
SH –75	LR –83	NP –83
MC –84	FC –80	EB –80
OR –72	GS –78	CM –70
ES –85	TS –83	DS –80
HS –78	HF –81	BK –79

When the physics grades and the preliminary test marks were averaged we have the following result. The students were divided into groups of eight each so that the total values of the three groups were approximately equal, viz:

	Group A	Group B	Group C
	GM –80	GC –80	SG –75
	HT –70	RC –71	HF –74
	FB –68	EB –66	FK –70
	SH –67	LR –68	NP –66
	Mc –65	FC –65	EB –63
	OR –56	GS –56	CM –63
	ES –59	TS –65	DS –62
	HS –62	HF –57	BK –54
Total	527	528	528

Result of the preliminary test for standardization of the three lessons:

Pupils	Lesson I.	Lesson II.	Lesson III.
A	25	15	18
B	14	8	11
C	13	18	12
D	6	19	19
E	9	15	19
Total	67	75	79

On the basis of this test the lessons were revised so the first was made a little more difficult and the last easier.

6. Final Experiments.

Tables I, II and III give a complete record of the various tests in the order of their sequence of performance.

TABLE I.—LESSON I.

Group A.—Text-book	mmediate	1 Week	4 Weeks
GM	67.5	77.5	67.5
HT	75	67.5	62.5
FB	70	55	45
SH	57.5	55	45
MC	90	80	50
OR	62.5	75	45
ES	80	7.5	60
HS	85	75	60
Total	587.5	562.5	435
Group B—Lecture			
GC	85	70	62.5
RC	62.5	55	45
EB	70	45	32.5
LP	90	72.5	50
FC	52.5	55	55
GS	70	40	35
TS	80	60	50
HF	45	55	40
Total	555	452.5	370
Group C.—Laboratory			
SG	75	55	55
HF	70	60	60
FK	70	50	62.5
NP	75	52.5	55
EB	70	55	55
CM	80	62.5	55
DS	90	67.5	65
BK	70	60	57.5
Total	600	462.5	465

TABLE II—LESSON II.

Group A.—Laboratory

	Immediate	1 Week	4 Weeks
GM	87.5	85	70
HT	77.5	67.5	45
FB	55	50	50
SH	70.5	55	50
MC	75	50	50
OR	70	50	40
ES	90	55	55
HS	70	65	60
Total	595	477.5	420

Group B.—Text-Book Recitation.

GC	85	85	45
RC	70	75	35
EB	50	45	10
LP	67.5	30	25
FC	80	67.5	55
GS	60	35	25
TS	70	72.5	60
HF	60	40	25
Total	542.5	450	285

Group C.—Lecture.

SG	75	55	37.5
HF	87.5	45	35
FK	75	70	50
NP	70	53	35
EB	65	45	60
CM	77.5	45	45
DS	90	80	85
BK	60	50	55
Total	600	445	402.5

TABLE III.—LESSON III.

Group A.—Lecture.

	Immediate	1 Week	4 Weeks
GM	70	60	45
HT	58.5	45	40
FB	55	25	40
SH	60	50	45
MC	35	35	35
OR	60	40	40
ES	75	45	55
HS	52.5	45	30
Total	466	345	330

Group B.—Laboratory

GC	55	40	32.5
RC	65	52.5	40
EB	60	42.5	35
LP	50	40	35
FC	60	62.5	30
GS	30	25	30
TS	70	50	30
HF	45	37.5	25
Total	435	350	257.5

Group C. Text Book.

SG	67.5	45	50
HF	50	40	35
FK	65	70	40
NP	65	55	50
EB	77.5	55	55
CM	70	60	50
CM	70	60	50
DS	80	70	70
BK	45	45	37.5
Total	520	440	387.5

In comparing the results of Table I we find that Group C taught by the laboratory method has the highest record, for the immediate test and for the final test. The one week test favors the text book method. Group B taught by the lecture method is the poorest for all three tests.

Table II shows the results of Lesson II, "Why is Baking Powder used in cake?" and indicates approximately the same standing for each group as in Table I. Group C shows the highest record for the immediate test. This group was taught by the lecture method. However for the one week and the four week test Group A, taught by the laboratory method, give the best results. Thus in both Lessons I and II the laboratory gives the best permanent results. The immediate result varies, in the first case it is the laboratory and in the second case it is the lecture method which is the best. In each case, however, it is Group C that receives the highest immediate result.

In Table III we find that Group C again receives the highest score, and this time it is with the text-book method. Both the one-week and the four-week tests for retention are like the immediate reproduction and Group C or the text-book method gets the honor. The laboratory method here is the poorest for both the immediate and the final tests. Group C in every case has the highest result irrespective of the method, which indicates that this group is slightly superior in mental ability to the other two groups. It would then be a better test of the methods to compare the results of each group in regard to the three lessons taught that group. In other words compare the lessons rather than the groups. This will eliminate the difference in mental calibre of the groups but will not consider the difference in difficulty of the lessons.

The results compared according to lessons are:

TABLE IV.—*Group A.*

Lessons	Immediate	1 Week	4 Weeks
Lecture–3	466	345	330
Text-Book–1	587.5	562.5	435
Laboratory–2	595	477	420

Here we see that the results again differ. In the immediate test the laboratory method is the highest but the retention is best by means of the text-book method. The lecture method in all three tests is far inferior to the other two, the text-book and the laboratory.

TABLE V.—*Group B.*

Lessons	Immediate	1 Week	4 Weeks
Lecture–1	555	452.5	370
Text-Book–2	542.5	450	285
Laboratory–3	435	350	257.5

Here the lecture method gives the best results both immediate and delayed. The text is second and the laboratory last. The results show very little difference in the percent. of retention in the different lessons.

TABLE VI.—*Group C.*

Lessons	Immediate	1 Week	4 Weeks
Lecture–2	600	445	402.5
Text-Book–3	520	440	387.5
Laboratory–1	600	462.5	465

In the last group, the lecture and the laboratory tie for first place, while after one week and four weeks the laboratory is conspiciously superior.

In all these tests there seem to be little superiority of one method over the other. This was also shown when we considered the work of the different groups in regard to the lessons. Even though the groups and lessons were of different calibre, the predominance of any one method would be apparent. This is not the case, for there is no record for any method that is conspicuously high in more than one or two cases.

We might look at the result now in toto for each group of tests according to the method taught.

The following tables give the results for the immediate, one week and four week tests in order to show the value of the method and also to check the lessons.

TABLE VII.

Immediate Resulty

Method	Lesson I.	Lesson II.	Lesson III.	Total
Lecture	555	600	466	1621
Text-book	587.5	542.5	520	1650
Laboratory	600	595	435	1630
Total	1742.5	1737.5	1421.0	4901

TABLE VIII.

Results After One Week.

Method	Lesson I.	Lesson II	Lesson III.	Total
Lecture	452.5	445	345	1242.5
Text-Book	562.5	450	440	1452.5
Laboratory	462.5	477.5	350	1290
Total	1477.5	1372.5	1135	3985

TABLE IX.

Results After Four Weeks.

Method	Lesson I.	Lesson II.	Lesson III.	Total
Lecture	370	402.5	330	1102.5
Text-Book	435	285	387.5	1107.5
Laboratory	465	420	257.5	1142.5
Total	1270	1107.5	975	3352.5

These tables show more distinctly the value of the three methods for giving immediate reproduction and delayed reproduction of facts. For immediate results the order is text-book best, laboratory second and lecture third. For results after one week we find the following order: Text-book, laboratory, lecture. And, for retention at the end of four weeks we find the following order: Laboratory, text-book, lecture. In every case the lecture proves the poorest, while the difference in the results of the laboratory and text-book methods is not so marked. From a study of the rate of forgetting it would appear that if we carried out these tests at still longer intervals the laboratory method might prove distinctly superior to the other two methods. The text-book method is shown by these studies to be superior to the other methods, but if we could extend the curve, we would perhaps find that the pupils taught by the laboratory method would retain the facts the longest.

We also see by the tables that the three lessons differ considerably in difficulty. The first two lessons are quite evenly matched, but the third lesson is appreciably more difficult. This is apparent in all three tests. The individual results for each lesson would therefore vary, and the truer record is obtained not by considering the results individually but as a whole as we have just done. We might even consider a complete total for the three methods, as follows:

TABLE X.

Tests	Text-Book	Lecture	Laboratory
Immediate	1650	1621	1630
One Week	1452.5	1242.5	1289.5
Four Weeks	1107.5	1102.5	1142.5
Total	4210	3966	4062
Average	1403	1322	1354

In order to compare the individual differences of the pupils for each method we may add the immediate and delayed results together and plot these. Such a graph will not only show the individual differences but also the relative value of each method. The data is given in Table XI.

TABLE XI.

Totals for Immediate and Delayed Reproduction.

	Pupil	Text-Book	Laboratory	Lecture
Group A	HS	220	195	127.5
	MC	220	175	105
	ES	217.5	200	175
	GM	212.5	242.5	175
	HT	205	190	143.5
	OR	182.5	160	140
	FB	170	155	120
	SH	157.5	175	155
Group B	GC	215	127.5	217.5
	TS	202.5	150	190
	FC	202.5	152.5	162.5
	RC	180	157.5	162.5
	HF	125	107.5	140
	LP	122.5	125	212.5
	GS	120	85	145
	EB	105	137.5	147.5
Group C	DS	220	222.5	255
	EB	187.5	180	170
	CM	180	197.5	167.5
	FK	175	182.5	195
	NP	170	182.5	158
	SG	162.5	185	167.5
	BK	127.5	187.5	165
	HT	125	190	167.5
Average		175	169	165
M. V.		30	28	23

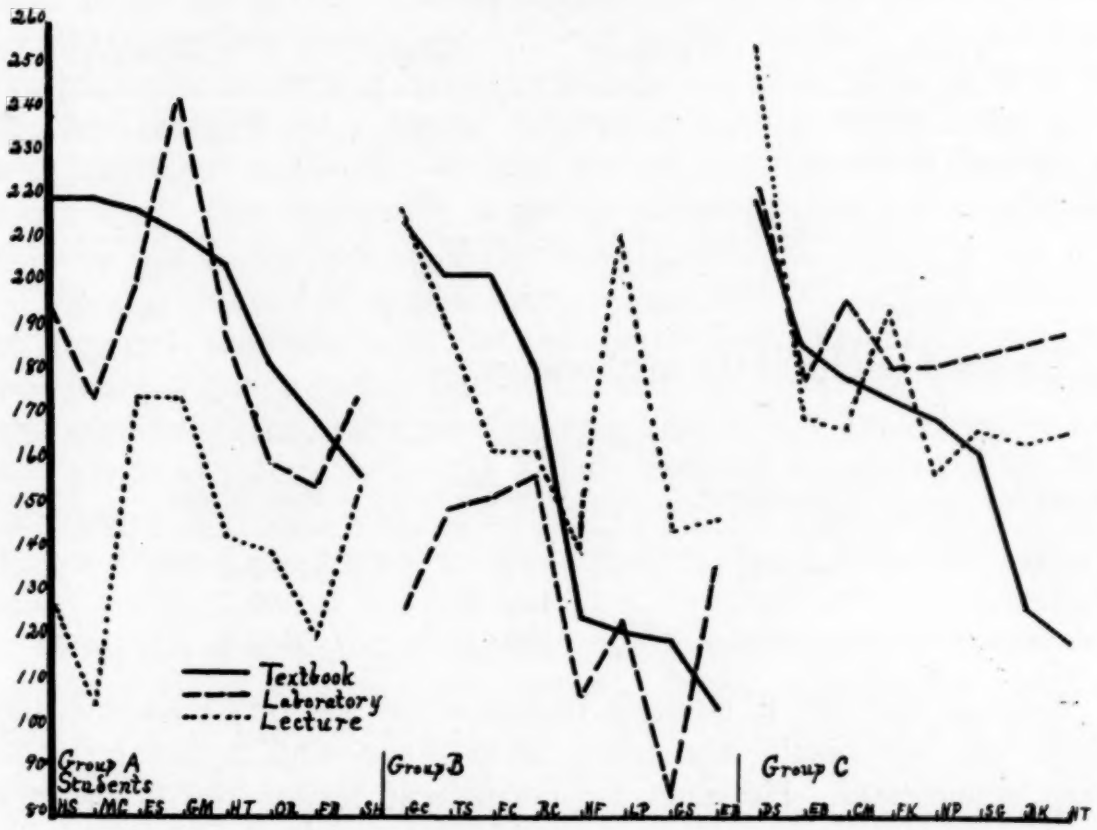

Figure 1. Total scores made by individuals of each group by each method.

Figure I shows the individual variation in the different methods. The curves in the first part, Group A, are quite regular and become very irregular in the middle part, Group B. In the last part, or Group C, they follow each other quite regularly again. The high record held by the text-book method is quite apparent all through the graph. In the first part the lecture method is lowest, in the second part the highest, and in the third part it holds second place. In the third part of the graph the laboratory method holds the first place. This graph shows better than any of the others the great variations, not only in the groups, but among the individuals themselves. Inspection of Table XI shows that the larger the average the greater is the mean variation for the three methods.

So far we have considered only the quality of the work done, irrespective of the time taken to accomplish it. But economy in learning must consider two factors; the quality of the results, and the time required to accomplish the results. Equal results may be produced by any method, but economy in learning requires that we get the result with the least expenditure of time. The time required to teach each lesson may be tabulated thus:

TABLE XII.

Lessons	Text-Book	Lecture	Laboratory
I	28	22	53
II	21	33	38
II	30	28	41
Total	79	83	132
Average	26.3	27.7	44

The total results of the methods are:

TABLE XIII.

Lessons	Immediate	One Week	Four Weeks	Time
Lecture	1621	1242	1102.5	27.7'
Text-Book	1650	1452.5	1107.5	26.3'
Laboratory	1630	1290	1142.5	44'

We find that for immediate reproduction the text-book method yields the best results and takes the least time and is therefore the most economical. However for permanent results the laboratory method yields slightly the best results and the amount forgotten is less, but the time is far greater than by either of the other methods. If it is merely a question of immediate result the laboratory method is wasteful, and even when we consider the amount of retention after four weeks the slight superiority of the laboratory method scarcely compensates for the extra expenditure of time. There are other advantages, however, that the laboratory method has over the text and lecture methods which we cannot consider here.

SEX DIFFERENCES

On the basis of the material which we have at hand we may inquire what differences are shown by boys and girls in connection with the different methods of teaching chemistry.

TABLE XIV.

Average Scores by Sexes.

Method	Immediate		One Week		Four Weeks		Total	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
Lecture	67.5	69.4	52.5	51.3	45.6	46.1	165.8	166.8
Text-Book	68.4	69.4	63.7	59.0	40.3	49.7	172.5	178.2
Laboratory	60.3	71.7	50.9	55.2	43.7	49.5	155.0	176.4

The average results of the different methods considered on the basis of sex show that in every method the girls outstrip the boys. In the immediate results the girls are higher in every method and exceptionally so in the laboratory method. The same is true of the final results but here the difference is great in both the text and laboratory methods. In the lecture method the difference is much less. The superiority of girls in retention after longer periods may be due to the nature of the lessons selected.

The distribution of grades, shown in Table XI and graphically in Figure 1, indicates that the tests were unequally balanced. As was pointed out in connection with Tables VII-IX, the third lesson was distinctly more difficult than the other two. This third lesson was given to Group A by the lecture method, to Group B by the laboratory method, and to Group C by the text-book method. Hence these three curves in the corresponding groups are unduly low.

From the standpoint of hygiene, there is no doubt as to the superiority of the laboratory method. From observation of the pupils during the teaching of the lessons their attention and interest reached its climax in the laboratory work. Restlessness, sliding down in the chair, looking out of the window, looking around the room, tapping with a pencil, with the fingers and feet, absent-mindedness, etc., were all noticeable in the lecture method especially. In the text-book method some such signs were apparent but not nearly so much as in the lecture method. Attention and interest, however, in the laboratory method seemed always at a high point. I know of no instant when the students were not absorbed in the laboratory work. As far as fatigue is concerned the periods were too short to produce much of it with pupils of this age. Early signs of it were perceptible, however, in the lecture method, but not in the laboratory work. The laboratory method is therefore the most hygienic and the lecture method the least.

Conclusion

1. There is not as great difference as is ordinarily supposed in the value of the three methods, lecture, text-book and laboratory, so far as imparting knowledge is concerned.

2. For immediate learning the text-book method is unquestionably superior.

3. For permanent learning the laboratory method is perhaps slightly superior.

4. In every respect the lecture method is the least effective in imparting knowledge to high school students.

5. From the point of view of the expenditure of time the laboratory method is the most costly and the textbook method the least. Ranking the methods in the order of economy of time they would stand: (1) Text-book, (2) lecture, (3) laboratory.

6. The rate of forgetting is greatest with the text-book method and least with the laboratory method. Whether the difference is enough to counterbalance the greater expenditure of time and thus make the laboratory method the most efficient is open to question.

7. Girls learn more readily than boys by all the methods, and more especially by the laboratory method. The question might be raised whether this is due to a greater retentiveness on the part of the girls, or a more careful attention to details in the learning process.

8. The different methods show decided individual differences both for immediate and delayed reproduction.

9. Probably a combination of the three methods will give the best results in the teaching of high school chemistry.

A TEST IN FIRST YEAR CHEMISTRY[1]

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In the development of tests of intelligence a distinction has been drawn between knowledge tests and performance tests. One of the chief criticisms that have been made of the tests in the Binet scale is that they are too specific, that they call for relatively isolated bits of knowledge, that they are more indicative of the range of acquired information than of native abilities. Therefore we find other investigators, as Goddard, Healy, Terman, and Pintner, turning their attention to performance tests as more symptomatic of basic intelligence.

In the experimental investigation of attainments in school subjects a similar distinction may be made between tests of the range of information and tests of skill in performance. Here the performance tests have received by far the most attention. For this there are at least two reasons. First, the greater part of the elementary school course is devoted to formal, instrumental, rather than content subjects. The work in reading, in arithmetic, in drawing, in handwriting, and to some extent in spelling and grammar has been directed chiefly to the development of a generalized ability to meet situations rather than to the acquisition of specific informational content. That such ability is valuable and necessary is not to be denied, but there is reason to believe that the formal, drill aspects of elementary school work have been over-emphasized, to the neglect of knowledge of physical and human nature, history, literature and art. The same is true in large measure of the high school. Second, it is easier to measure such assumed general ability than it is specific information. All of our reading scales are constructed on the basis of testing the general ability to read, with little regard to the content of what is read. We have no scales to measure the child's knowledge and appreciation of poetry, of biography, of history, of novels, of short stories. All work in elementary arithmetic is necessarily formal, but until recently we have confined our attention to the four fundamental operations and a few random problems in reasoning. Few attempt have been made to explore the child's knowledge of fractions, of decimals, of denominate numbers,

[1] A preliminary account of this study was read before the Chemistry Section of the Central Association of Teachers of School Science and Mathematics at Columbus, Ohio, December 1, 1917, and appears in the May number of *School Science and Mathematics.*

of percentage, of involution and evolution. No scientific studies have yet been made of the school child's knowledge of animal and plant life, of the structure and functioning of his own organism, of his relations with his social environment, and we have only a few fragmentary efforts to determine his knowledge of geography and history. The range of possible knowledge in these subjects is so great and the attainments of a given child depend so much upon the circumstances of his environment that it is extremely difficult to construct tests that will give an adequate measure of the range of his information.

In attempting to determine the attainments of high school pupils in a natural science, like chemistry, we are again confronted by the performance and the informational aspects of the situation. We may ask what can the child *do* in chemistry, or we may inquire what does he *know* about the facts of chemistry. A complete measure of his attainments would, of course, include both. In determining his performance we might take him to a chemistry laboratory and confront him with a series of chemical situations typical of the work in elementary chemistry. This would be the most concrete and thorough test of his performances in chemistry, but would involve much time, expense, and effort in carrying out the test. A second method of procedure would be to confront him with a list of problems and ask him to indicate on paper what he would do in the solution of these problems. This type of test lacks the concreteness of the actual laboratory situation, but requires less time and expense, can be conducted with a large group of students at one time, and has the added advantage of affording a test of the pupil's scientific imagination. The writer believes that this type of problem test offers a rich field for experimental investigation which has been almost entirely neglected.

The present study was confined to the informational aspect of elementary chemistry. The question proposed was, what do high school pupils who have had one year of chemistry know about the subject? The study was further limited geographically to certain representative high schools in the state of Texas. The first problem in such a study is to determine the scope of elementary chemistry and the relative importance of the main topics taken up in the course. The ideal method of procedure here would have been to ascertain from the teacher of chemistry in each of the schools in question the topics covered in the course, and the appropriate amount

of time and attention devoted to each. This would have taken more time than could be allowed for the preliminary work, so recourse was had to a study of representative texts in elementary chemistry and of the recommendations sent to high schools by the chemistry department of the University of Texas. These recommendations are generally followed in the teaching of chemistry in Texas high schools, and serve to standardize the treatment of the subject. The next task was the selection of the specific questions that should constitute the test. If time had allowed, it would have been desirable to make an extensive preliminary study here by formulating a considerable number of questions on each topic, perhaps 200 or 300 in all, and submitting these to a large number of representative teachers of chemistry in different parts of the country (or perhaps merely to the teachers of the schools to be studied) with the request that they either rank the questions in the order of their importance, or indicate in some other manner the ones they considered most important. From a statistical treatment of the returns one could readily determine the questions that were considered of greatest importance by teachers of chemistry, and on this basis one could construct a test that would cover the most important points in elementary chemistry. In the present instance such an elaborate study was inexpedient, so that the questions had to be selected on the basis of individual opinion, supported by personal consultation with as many teachers of chemistry as could be interviewed.[2]

In formulating these questions the effort was made to state the question briefly, clearly and unambiguously, to call for such information as could be given in a few words, and to so frame the question that the answer could be marked as either right or wrong. All answers were to be written on the question sheet. When the papers were returned, however, it was found that some of the answers were partly right and partly wrong, so it was decided that a better indication of the abilities of the pupils would be afforded by giving one credit for correct answers, one-half credit for answers partly correct, and no credit for those entirely wrong. At the top of the sheet were blank spaces in which the pupil was asked to write his name, the name of the school, the date, the amount of chemistry he had studied, and the date of this study. The questions proposed were as follows:

[2] For this work the writer desires to express his obligation to Mr. R. G. Upton, an experienced teacher of chemistry, who was at that time assistant in the school of the Art of Teaching at the University of Texas.

CHEMISTRY TEST

1. What chemicals are liberated in electrolysis of water?
2. What gas is given off by the action of yeast in bread dough?
3. Name two chemicals used in making oxygen.
4. Express in cubic centimeters one litre.
5. Name two substances used in making hydrogen.
6. Define oxidation.
7. Define reduction.
8. Name four processes of purifying water.
9. What is a deliquescent substance?
10. Name two gases either of which might be used to bleach cloth or flowers.
11. Name two very common organic acids.
12. Name two chemical compounds used in making common salt.
13. Write the reaction for sulphuric acid on potassium hydroxide.
14. Name the two most abundant elements in the atmosphere.
15. Name two commercial sources of ammonia.
16. Is air a chemical or physical mixture?
17. Why does ammonia water always feel cold when it comes in contact with the hands?
18. Name substances used to make aqua regia.
19. Name four basic hydroxides.
20. Name the commercial uses of the nitrates.
21. What are the properties of carbon bisulphide?
22. Give chemical name of $CaSO_4$....., H_2S....., Na_2SO_3.....
23. What is the valence of H....., of O....., of Ca....., of SO_4.....
24. Name the members of the chlorine group.
25. How many grams of water are formed by the combustion of 10 grams of hydrogen in the air? (Work on this paper).

Returns were received from the chemistry classes in the high schools of sixteen Texas cities. The city of Galveston returned papers from an elementary class and from an advanced class, and if these are counted separately (as is done in the tables) we have data from seventeen groups. Texas high schools begin their year's work about September 15. The papers were sent to the schools about May 10, and the tests were given about May 15. As the schools close about June 1, the work of the year had been practically completed. The pupils in fourteen of these schools had thus studied chemistry just eight months. In San Antonio the work had been begun late in the year, so that three months' study was reported. Thus San Antonio and the two groups from Galveston (one with three months' study and one with twelve months', should be considered by themselves.

THE RESULTS

A summary of the results is presented in Table I. The cities in which the high schools are located are given in alphabetical order. Column one gives the number of pupils in each group. It is probable that in the larger cities, as Fort Worth, Dallas, and Corpus Christi, these groups were divided into two or more sections, but there was nothing in the returns to indicate the sections. The classes are seen to be of moderate size, and are probably representative of chemistry classes in towns of less than 100,000 inhabitants. Each group is composed of both boys and girls, and of the entire number of four hundred papers received, one hundred and ninety-eight were from boys and two hundred and two from girls. It is somewhat surprising that so much interest should be shown in chemistry by girls. It is ordinarily assumed that girls prefer such studies as languages, literature and history, and that in elective courses in natural science boys predominate. It would be interesting to know whether studies in other parts of the country would show a similar equality in numbers of boys and girls taking chemistry.

As the returns were received, the papers were carefully gone over and each answer was marked right, partly right, or wrong. These marks were then transferred to score sheets presenting the individual responses made by the pupils to each question. Each pupil's total score was then computed and expressed as a per cent. of the maximum. The average of these per cent. scores was taken as the index of the group. Likewise the number of correct responses made by the group to each question was computed and expressed in terms of per

TABLE I

Percentage Score on Each Question

	No. Pupils	Months	No. of Question 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	Average	No. Boys	Av. for Boys	No. Girls	Av. for Girls
1. Beeville	23	8	87	91	83	9	76	58	48	35	30	72	83	35	61	65	24	48	22	67	67	24	24	70	78	83	26	56	9	54	14	57
2. Brownwood	17	8	100	100	100	83	100	95	89	75	64	83	95	75	75	92	50	95	42	86	97	64	31	61	89	100	39	78	11	75	6	76
3. Coleman	15	8	100	100	97	74	93	67	63	53	93	80	87	40	74	80	17	80	63	74	87	50	40	60	60	90	13	69	3	72	12	68
4. Corpus Christi	44	8	83	82	77	68	88	86	83	40	11	65	31	61	97	69	12	48	48	73	91	22	15	64	99	98	18	59	20	64	24	55
5. Dallas	46	8	100	98	62	42	96	89	84	77	39	76	51	46	64	84	34	70	28	58	87	40	24	85	86	57	63	63	16	76	30	56
6. Del Rio	13	8	100	100	69	0	69	69	77	65	69	81	92	69	89	81	8	69	58	81	69	8	15	77	85	92	27	65	8	61	5	71
7. Denton	18	8	95	95	36	67	97	33	33	67	28	64	19	61	75	75	6	95	39	11	58	19	22	47	70	92	6	52	14	54	4	44
8. El Paso	21	8	95	91	21	79	57	76	79	53	55	62	55	60	95	88	26	76	60	84	76	41	31	76	88	95	21	65	15	66	6	55
9. Ft. Worth	50	8	97	99	71	77	79	76	66	65	76	83	44	68	75	91	13	78	18	77	89	47	12	66	85	98	54	69	16	71	34	68
10. Garland	16	8	94	81	81	44	94	50	19	53	31	59	31	28	3	56	22	31	19	91	78	22	9	41	3	88	0	45	7	48	9	42
11. Lockhart	14	8	100	100	82	72	93	100	100	89	93	68	93	93	97	93	57	72	29	61	100	39	46	75	93	100	72	81	7	87	7	75
12. Mexia	21	8	95	95	50	86	62	55	19	53	53	74	0	17	50	57	2	67	33	33	53	26	0	57	36	91	10	47	12	53	9	39
13. San Marcos	28	8	70	29	7	32	29	39	7	41	0	57	43	21	57	54	2	39	29	9	86	9	34	57	61	63	0	36	13	38	15	34
14. Uvalde	10	8	90	100	0	80	50	60	60	45	60	65	30	20	30	70	0	60	0	40	45	55	0	50	45	40	40	45	6	44	4	47
Average	24		93	90	60	58	77	62	59	58	50	71	54	50	67	75	20	66	35	60	77	33	22	63	70	85	28	59	11	62	13	56
15. Galveston, Adv	14	12	100	93	79	72	89	100	86	72	68	72	79	79	97	86	39	86	43	82	89	57	18	86	86	100	36	76	8	79	6	73
16. Galveston, Elem	14	3	90	7	50	93	50	57	0	46	7	43	11	39	61	82	0	79	21	0	68	14	0	29	50	0	0	36	10	39	4	29
17. San Antonio	36	3	97	83	67	60	78	76	33	54	72	71	58	53	56	88	32	51	50	39	56	40	18	61	60	58	28	58	23	60	13	54

cent. of the maximum. These percentages for each question are shown in Table I in the columns numbered from 1 to 25. The column marked Average presents the average total score or index for each group. Examination of this column shows that the average index for the fourteen schools whose pupils had studied chemistry for eight months was 59. The range is from 81 (Lockhart) to 36 (San Marcos). This ratio is well over two to one, and shows that there is a vast difference in the chemistry teaching in Texas high schools. This sets an interesting problem which calls for further investigation. What is the reason for this wide range of scores? That it is due to individual differences in pupils is scarcely likely. One might think that in the larger schools the individual pupils do not get as much attention, and hence their showing is not so good. Inspection of the table, however, does not bear out this assumption. On the contrary, the larger schools, Fort Worth, Dallas, and Corpus Christi, show a combined score that is well above the average, while the small schools, Garland, Mexia, and Uvalde, are near the bottom of the list. In the absence of other evidence we suspect that the chief reason for the difference is to be found in the individual teacher, and that in general the larger towns pay the better salaries and get the better teachers. Lockhart, Brownwood and Coleman, however, all small towns, stand at the very top of the list, and thus tend to weaken the force of this hypothesis.

Table II gives the percentile distribution of the individual scores made in each school. It will be seen that the score of the best pupil is usually more than twice as good as that of the poorest in the same class, and in one case (San Marcos) it is almost four times as good. Marked exceptions to this are Brownwood and Lockhart, where the pupils are fairly close together, and all stand high. From the entire body of four hundred pupils, only one (Roland Bond, of Dallas) made a perfect score, or 100 per cent. Other high scores were made by Pliny Dell Valle, Dallas (98 per cent.); J. D. Miller, Dallas (92 per cent.); Alfred Harrys, Denton (94 per cent.); Hilmar Karbach, Lockhart (94 per cent); and Harry Galloway, Lockhart (92 per cent). On the other hand the lowest score (16 per cent.) was made by a boy in the San Marcos school, and of the lowest ten scores six are to be credited to that school. This difference between the highest and the lowest schools can be clearly seen in Table I. Lockhart, with an index of 81, had 100 per cent. correct on six questions, and 75 per cent. or better on sixteen of the twenty-five questions, while the

TABLE II

Range of Individual Scores in Each School

	Lowest	Percentile									Highest
		10	20	30	40	50	60	70	80	90	
1. Beeville	18	36	38	38	50	56	58	62	66	74	90
2. Brownwood	66	68	70	76	78	80	82	82	86	86	88
3. Coleman	34	50	60	62	70	74	74	80	80	84	88
4. Corpus Christi	42	48	50	54	56	60	64	66	72	78	86
5. Dallas	40	46	52	56	60	66	68	70	78	80	100
6. Del Rio	40	56	58	58	62	66	70	74	78	78	82
7. Denton	32	34	38	42	46	50	52	54	62	86	94
8. El Paso	46	46	52	60	62	68	70	72	78	78	84
9. Ft. Worth	38	58	62	66	68	70	72	74	78	80	84
10. Garland	24	34	36	38	40	44	46	46	52	60	70
11. Lockhart	66	72	76	78	80	82	84	84	88	90	94
12. Mexia	28	34	38	40	42	48	50	52	54	64	70
13. San Marcos	16	18	22	26	34	38	46	48	52	52	62
14. Uvalde	22	30	32	38	44	46	46	58	58	58	78
15. Galveston, Adv	50	62	68	70	72	84	84	84	84	86	88
16. Galveston, Elem	20	28	32	34	36	36	36	40	42	44	54
17. San Antonio	30	32	38	42	48	56	60	68	76	82	86

lowest question had 29 per cent. San Marcos, with an index of 36, made no higher score than 86 per cent. on any question, had only eight questions over 50 per cent., received scores of less than 10 per cent. in seven questions, and failed entirely on two questions. The widest difference between extreme scores is seen in Beeville, where the range is from 18 to 90.

In addition to the scores of the fourteen schools already discussed, Table I presents the results from the two classes in Galveston and from the San Antonio high school. Evidently the elementary class in Galveston had not gone very far in chemistry, for on six of the questions no score at all was made. The index for the class was 36, which although it is not high, is proportionately much better than the showing made by some of the schools after eight months of study. The advanced class, with twelve months of study to its credit, presents an index of 76, which is higher than that of any other school except two, but is carecely a showing adequate to the greater amount of time spent on the subject. The large class in the San Antonio

high school, on the other hand, after only three months of study, attains an index of 58, a score within one point of the average of the indices of all the eight months schools. Moreover, an inspection of the scores made on the individual questions shows that the attainment was remarkably even and well-balanced. With the time and other factors included in the reckoning perhaps San Antonio makes the best showing of any of the schools.

Attention has already been called to the fact that the number of boys and girls taking the test was practically equal. This does not apply to the individual schools. In the larger schools, as Fort Worth and Dallas, the girls outnumber the boys approximately two to one, while in the smaller towns the boys are usually in the majority. In the general average of attainments, however, the boys are distinctly superior to the girls, the scores standing 62 for boys to 56 for girls. This is not only true of the general average but applies to the schools individually, only four classes of the seventeen showing a higher score for the girls than for the boys. The superiority of the boys is especially marked in Corpus Christi, Dallas and Lockhart, while in Fort Worth and San Antonio it is not so pronounced. It is noteworthy that the group of pupils having the highest ten scores is composed exclusively of boys. Likewise the lowest two scores were made by boys, out of the lowest ten five were boys and five were girls. So far as it goes, therefore, this investigation supports the contention that boys are more variable than girls

Table I shows not only the average score of each school on each question, but also the average scores of the fourteen schools that had had chemistry for eight months. These averages are made directly from the school scores, and are, therefore, on the basis of the same number of pupils for each school. It is of interest to compare the different questions from the point of view of the responses made to each. Table III presents the questions in order of increasing difficulty, or at least in the decreasing magnitude of the average score. As might be expected, the electrolysis of water is the most familiar, with the action of yeast in bread dough a close second. These facts are easily retained, owing to their connection with daily life. The knowledge of the members of the chlorine group is more technical, and it is somewhat surprising that the question receives such a high score. These three questions are, therefore, in a group by themselves. The next seventeen questions show a regular decrease in score from 77 to 50. Seven of these questions lie within

TABLE III.

Questions Arranged in Order of Increasing Difficulty.

Per cent.	No. of Question.	Question.
93	1.	What chemicals are liberated in electrolysis of water?
90	2.	What gas is given off by the action of yeast in bread dough?
85	24.	Name the members of the chlorine group.
77	5.	Name two substances used in making hydrogen.
77	19.	Name four basic hydorxides.
75	14.	Name the two most abundant elements in the atmosphere.
71	10.	Name two gases either of which might be used to bleach cloth or flowers.
70	23.	What is the valence of H, of O, of Ca, of SO_4?
67	13.	Write the reaction for sulphuric acid on potassium hydroxide.
66	16.	Is air a chemical or physical mixture?
63	22.	Give the chemical name of $CaSO_4$, H_2S, Na_2SO_3.
62	6.	Define oxidation.
60	3.	Name two chemicals used in making oxygen.
60	18.	Name substances used to make aqua regia.
59	7.	Define reduction.
58	4.	Express in cubic centimeters one litre.
58	8.	Name four processes of purifying water.
54	11.	Name two very common organic acids.
50	9.	What is a deliquescent substance?
50	12.	Name two chemical compounds used in making common salt.
35	17.	Why does ammonia water always feel cold when it comes in contact with the hands?
33	20.	Name the commercial uses of nitrates.
28	25.	How many grams of water are formed by the combustion of 10 grams of hydrogen in the air?
22	21.	What are the properties of carbon bisulphide?
20	15.	Name two commercial sources of ammonia.

a range of five points (63 to 58). The last five questions are so much lower that they form another distinct group. Perhaps Question 17 deals with a phenomen that is more physiological than chemical, but the facts are usually brought out in connection with laboratory work. Evidently the commercial uses of nitrates and of ammonia receive very little attention in these chemistry classes. Is this another indication of abstract formalism in science teaching, and of neglect of the concrete applications of the science?

Table IV affords a comparison of the attainments of the best ten and the poorest ten of the entire four hundred pupils. Of the twenty easier questions the good group made 100 per cent. on fifteen, 95 per cent. on four, and 85 per cent. on one. Their lowest score was

TABLE IV.

Average of Highest Ten and Lowest Ten Pupils

	Average Total Sorce	No. of Question												
		1	2	3	4	5	6	7	8	9	10	11	12	13
Average of highest ten pupils..	.93	100	100	95	100	100	100	100	95	100	95	100	100	100
Average of lowest ten pupils..	..20	65	20	5	50	10	20	0	30	10	35	20	5	10

	14	15	16	17	18	19	20	21	22	23	24	25
Average of highest ten pupils.....	100	55	100	70	85	95	70	75	100	100	100	80
Average of lowest ten pupils.....	50	5	30	10	5	50	5	0	10	30	15	0

55 per cent., on the commercial uses of ammonia. The scores of the lowest ten seem to be quite erratic. They agree with the others in showing the greatest familiarity with the components of water, but otherwise there is no agreement either with the highest ten or with the entire group. On three questions they get 50 per cent. One of these is purely mathematical, one deals with the elements in the atmosphere, and only the last (name four basic hydroxides) depends strictly on a study of chemistry. Three of the questions (Nos. 7, 21, and 25) arouse no trace of accurate response.

The present study is tentative, incomplete, and limited in its scope. It would be desirable to have more information regarding the text-book used in each school, the topics emphasized in the course, the number of recitations per week, the amount and character of the laboratory work, and the point of view of the teacher. The range of questions might well be amplified, and correlated studies should be carried on with other high school subjects. A study of school marks in chemistry should go along with such testing. It is hoped that this article may stimulate others to make similar and more thorough investigations.

THE RANGE OF INFORMATION TEST IN BIOLOGY. I. PHYSIOLOGY*

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The fact that the human mechanism has been studied previously in the grades, suggests two possibilities to those concerned with the effective teaching of high school physiology and its proper place in the course of study:

1. The knowledge acquired in the grades may be disjointed and fragmentary. In the words of a writer on the relation of this subject to high school zoology: "We may not assume that the pupils have brought from the elementary schools any accurate knowledge of physiological principles and processes." If this be so, the problem before the high school is evidently that of utilizing somehow this previous knowledge, whatever the type of course to be given.

2. On the other hand, physiology may hold no justifiable place in the high school course of study, for, barring anatomical detail and technical terminology, grade-school pupils, when entering the high school, may already possess a *reasonable* amount of information concerning the human body. In the opinion of the writer previously quoted, "High School physiology adds nothing but details, except as it enters upon the fields of the high school sciences, thus producing a wasteful duplication of work."

So far as the present writer is aware, neither of the statements of the author cited rests on detailed evidence from which a conclusion one way or the other could be drawn. Recognition of the two possibilities has resulted in the proposal of various new types of courses, such as "Social Biology," "Biology of Man," etc., diagnosed to meet both of them. With the idea of securing more definite data concerning these problems, the writer, at the suggestion of Dr. E. L. Thorndike, Columbia University, has conducted tests with first-year high-school students after the plan described by Whipple in his *Range of Information Test.* It is hoped that the results obtained afford partial solutions.

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*Read before Section L, A. A. A. S., January, 1918. Grateful acknowledgement for helpful criticism is due Mr. T. S. Henry, University of Illinois. Thanks are due to Mr. W. J. S. Bryan, Assistant Superintendent of Instruction, and Mr. C. B. Curtis, Principal, Central High School, St. Louis, for facilities offered in making this test.

The 100 test words were selected from the textbook used in the grades in the following manner. A list was first prepared of all those words pertaining more directly to physiology discovered in the spellers and readers previously used by the pupils in their grade-school work. A similar list was made from a number of the articles dealing with pure food and health to be found in the daily newspapers and more widely known monthly magazines. From these lists, 100 of the more frequently occurring words were checked in the glossary of the textbook as being (1) words in fairly common use, which, it was thought, cultural values to be derived from the science demanded that the pupils should know, (2) words a knowledge of which would indicate some familiarity with the care of the body, and the activities of its organs. Many of these terms, such as paralysis, ligament, etc., are now only semi-technical. An effort was made to distribute the words evenly among the divisions of the subject.

To make clearer the use of the test in this connection, the test blank is here reproduced with some desirable but slight modification. The pupils were asked to read the directions through twice before marking the words, their attention was called to the request for definitions as printed below the test words, and they were given all the time they needed. As a check on the marking of the pupils, the 100 words were defined by the examiner from the glossary of the grade-school textbook, and each pupil revised his own paper by placing a second series of marks after each word to indicate the manner in which he should have marked it. A comparison of the number of D's, E's, F's and N's of the first and second series will then show with a fair degree of accuracy the extent and nature of the error due to ignorance or misunderstanding of the real meanings. The results obtained may be found in the following tables classified as to dependence of range of information of physiology on:

1. Academic status.
2. Sex.
3. Academic status and sex.

By first-term students are meant those taking up the study of botany at the time. Second-term students are beginning physiology, having completed botany.

DIRECTIONS

NAME ..... DATE .....

Below are 100 words which are largely technical and which are designed to test the extent of the knowledge of physiology you gained in the grade school. Consider each word carefully.

1. Place a D before the terms you can DEFINE as exactly as words are ordinarily defined in the dictionary.
2. Place an E before the terms you can explain to one not familiar with their meaning.
3. Place an F before the terms with which you are roughly familiar.
4. Place an N before the terms which are new to you.
5. At the bottom write out the definitions of the first 5 words you marked D, and the first 5 you marked E.
6. Count the number of D's, E's, F's, and N's, and record the result at the top of the page in the 1 in. space.

D.	E.	F.	N.
1.	1.	1.	1. .....
2.	2.	2.	2. .....

abdomen
absorption
adulteration
antitoxin
aorta
artery
auditory canal
auricles
biceps
bicuspids
bile
bronchial tubes
bowels
capillary
carbohydrate
carbonic acid gas
cartilage
cerebellum
cerebrum
circulation of blood
congestion
convolution
cornea
corpuscles
contamination
cranium
curvature of spine
cuticle
diaphragm
digestion
disinfectant
dislocation
enamel
energy
epiglottis
epidemic
excretion
fainting
far-sighted
femur
forearm
fracture
germ
gland
gray matter
gullet
gymnastics
habit
hinge-joint
immunity
infection
inflammation
intestine
larynx
kidney
involuntary muscle
lead poisoning
ligaments
liver
lymph
marrow
massage
mastication
mucus membrane
muscle fiber
narcotic
nerve fiber
nitrogen
oxidize
patent medicine
pancreas
paralysis
periosteum
pigment
pneumonia
pore
pelvis
proteid
pulse
pupil
preservative
pus
quarantine
retina
saliva
sewer gas
spinal cord
sprain
stimulant
stomach
tartar
tendon
tissue
triceps
tuberculosis
urea
vein
ventricle
vocal cords
wind pipe

D.	E.
1.	1. .....
2.	2. .....
3.	3. .....
4.	4. .....
5.	5. .....

TABLE I

Dependence of Range of Information of Academic Status

A. (1st series)

ACADEMIC STATUS	NUMBER	D.	E.	F.	N.
1st-term pupils	40	17.3	13.3	18.1	51.3
2nd-term pupils	97	14.7	17.9	24.8	42.7

B. (2nd series)

ACADEMIC STATUS	NUMBER	D.	E.	F.	N.
1st-term pupils	40	24.9	17.2	11.5	46.4
2nd term pupils	97	20.3	24.1	22.1	33.4

Computation made from the first and second series of the preceding table indicates that with increase of maturity, there occurs also an increase in the number of technical terms that can be explained (E), or that are least familiar (F), a decrease in the number of terms that can be defined (D), among second-term students. The only reason for the latter which the writer may present is that the comparatively long time elapsing before high school physiology was taken up—a term and the summer vacation—had somewhat altered the conceptions of these pupils.

The increase of E's follows probably because certain of the test words are used in the preceding course, botany. Another factor possibly affecting the results is the knowledge obtained through the widespread propaganda against disease and for better living, inaugurated by various civic organizations, and the articles in magazines and newspapers forming a partial basis for this test. Knowledge of the body, of course, increases with age, and in a trial test of 12 young men of an average age of 20 (most of whom had never attended the high school), very high percentages of E's and F's were obtained and practically negligible percentages of D's and N's. The advantages of a high school course in physiology may be doubted under these conditions, a conclusion supported by the fact that in Table I-B, the number of words defined (D), explained (E), familiar (F), is decidedly greater than the words which are new. The average error of marking (difference between first and second gradings), in first-term students was 72 per cent., that of second term students, 64 per cent., showing that there also occurs with maturity some advance in discriminatory power.

These results, reclassified by sex, show a general superiority in boys in range of information of physiology. This is in accord with the results obtained by Whipple and Smith in their studies. Further evidence may be obtained for clearer concepts in boys than in

girls from the fact that the sum of N's in the second series is less and there is a greater percentage of D's and E's among the boys. The average error in boys was 56 per cent.; that of girls 8 per cent.

Attention may here be called to the fact that in most of the tables presented, there is a tendency for a greater percentage of D's to be that the percentage of error obtained by comparing these as groups is practically the same. As might be expected, the checking-up process diminishes the percentage of F's and N's, and increases the percentage of D's and E's.

TABLE II

Dependence of Range of Information on Sex

A. (1st series)

Academic Status	Number	D.	E.	F.	N.
High-school Boys	65	18.0	20.6	21.5	39.9
High-school Girls	72	13.1	12.9	24.0	50.0

B. (2nd series)

Academic Status	Number	D.	E.	F.	N.
High-school Boys	65	22.0	23.6	19.3	35.1
High-school Girls	72	21.4	21.0	18.5	39.1

The insight afforded by a mixed classification by sex and academic status is presented in Table III (A, B, C, D.) First-term boys (C and D) have a greater proportion of D's than first-term girls, and a slightly less number of E's. No difference with regard to F's and N's is noted from that of the preceding table. First-term girls however, have a lower percentage of error, 6.6 per cent., against 7.5 per cent.

Table III, (A and B), representing results from second-term boys and girls indicates that the boys secured a greater percentage of D's in the first series but that these percentages are practically equivalent in the second. In both series they had a greater percentage of E's and fewer F's than the girls. N's are distributed as in the preceding table. The percentage of error in the girls was 9.4 per cent.; that of the boys, 3.6 per cent. This may indicate a rapid change in mental powers at this period.

TABLE III

Dependence of Range of Information on Sex and Academic Status

A. (1st series)

Academic Status	Number				
2nd-term High-school Boys	55	16.8	22.2	22.5	38.5
2nd-term High-school Girls	42	11.8	12.2	27.8	48.2

B. (2nd series)

Academic Status	Number	D.	E.	F.	N.
2nd-term High-school Boys	55	20.8	25.4	20.6	33.2
2nd-term High-school Girls	42	19.9	22.9	23.6	33.6

TABLE III

Dependence of Range of Information on Sex and Academic Status

C. (1st series)

ACADEMIC STATUS	NUMBER	D.	E.	F.	N.
1st-term High-school Boys	10	24.8	11.8	15.8	47.6
1st-term High-school Girls	30	14.8	13.8	18.8	52.6

D. (2nd series)

ACADEMIC STATUS	NUMBER	D.	E.	F.	N.
1st-term High-school Boys	10	28.9	13.8	12.0	45.3
1st-term High-school Girls	30	23.5	18.3	11.4	46.8

A list of typical errors of definition follows—the word apparently the source of confusion indicated in parenthesis. Many illustrate erroneous impressions commonly met with in pupils, points which may furnish opportunities for objective attacks by teachers in solving the first problem indicated in this paper.

abdomen—the stomach: digestive part of body: bottom part of stomach containing the bowels.

absorption—taking up of water by air: taking in water or sunlight: taking in of oxygen.

adulteration—making food, drink or medicine weaker by adding water: to dilute with water.

antitoxin—a serum infected to certain diseases; mixture of blood of sick person to cure somebody else having same disease.

aorta—chief vein of body: blood vessel passing through lungs.

artery—a main vein: tube or muscle in the body carrying blood toward the heart: blood vessel for pure blood.

biceps—name applied to teeth inside of mouth (bicuspid): animal having two feet (biped): your legs.

bile—waste issuing from body after food is digested: place where food goes through (bowel).

bronchial tubes—tubes which make voice in throat.

bowels—part of stomach: part of stomach secreting waste: where food circulates.

carbohydrate—mixture of starch and sugar: a food consisting of nitrogen, sulphur and phosphate.

carbonic acid gas—gas obtained by eating zinc with hydrochloric acid (hydrogen).

cartilage—matter found in spinal column.

curvature of spine—caused by killing end of spine.

cerebrum—part of spine.

circulation of blood—way blood helps itself to flow: flow of blood through veins: working of blood in system.

congestion—to be crowded on outside: blocked passage-way.

convolution—cramps (convulsion): kind of nerve is drawn up and hit.

contamination—to catch a disease: disease that spreads.

cranium—term sometimes used in speaking of head.

cuticle—end of loose skin at finger nails.

diaphragm—line of dividing chest: separates stomach and bowels.
digestion—when the food is taken into the stomach: assimilation of food: process of chewing things and swallowing them: work of stomach preparing food for distribution over entire body: if the bowels move.
disinfectant—a liquid used for various cleaning purposes: exterminator of insects and germs: poison medicine: a substance to take away a bad odor.
dislocation—sprain or broken bone: breaking and changing a bone.
enamel—a kind of paint: white shiny layer of polish something of a granite color only white instead of spotted.
energy—will power: putting life into things.
epiglottis—outside skin (epidermis).
epidemic—drug used before and after operations to quite pain (anaesthetic). catching sickness in which 1-10 of population dies: over 100 cases of disease.
excretion—taking in of water by plants: overdoing it (exertion):
fainting—act of being unconscious: when heart loses 1 beat: weakening of nerves: falling into a certain mood: rushing of blood to top of your head.
far-sighted—cannot see but when he is far away: when one cannot see far: one who sees objects in front of them.
fracture—part of body dislocated.
germ—insect that carries disease: harmful insect: an insect in the body causing disease: a small insect that can be seen through the microscope.
gland—something that makes you see, as eye gland: part of neck.
gray matter—a poison formed when a cut is not attended to.
inflammation—you have a spasm or a fit (convulsion): when a person has a high degree of fever they are inflamed.
intestine—last stage of digestion: your inside consisting of kidney, bowels, lungs.
kidney—water preserver: an organ of the stomach.
ligaments—muscle tissues: kind of muscle in leg or arms.
liver—filters blood: part of the stomach.
marrow—white substance in the bone keeping them hard: fluid in bones.
oxidize—where carbon and oxygen unite to form a substance called oxide.
patent medicine—medicine for a special cause.
paralysis—drying up of marrow in bone but mostly in spinal cord: lameness of body which may cause death: stiffening of joints.
pupil—white part around part you see with: colored part of eye.
quarantine—to be kept in.
saliva—white matter from the mouth.
spinal cord—a continuous bone supporting the back: composed of 24 small bones from head to coccyx. (spinal column).
sprain—occurs when a bone is out of position: where not able to use ankle or arm.
stimulant—awake or moving: reviver.
tendon—something on the order of a ligament found in the legs.
tissue—soft meat of the body.
urea—salt water from body (urine).
vein—tube in body carrying blood to different parts of body.
ventricle—pipe in throat food goes down: sound without moving lips.
windpipe—tube which carries food to the stomach.

COMMUNICATIONS AND DISCUSSIONS

SCHOLARSHIP AND SUCCESS IN TEACHING

A question of perennial interest and one that provokes considerable discussion among educators and business men, "Is there any relation between scholarship and vocational success?" is the subject of this inquiry. The purpose of this study is to determine whether there is a relationship between scholarship and success in teaching. The data have been gathered from the rating in scholarship given students in the Harris Teachers College of St. Louis and the ratings given the same students as apprentices, temporary substitutes, permanent substitutes, and teachers in the St. Louis schools. The resident faculty members rate the students, and the grade school principals of the city rate the apprentices, the temporary substitutes, the permanent substitutes, and the grade teachers.

An explanation of terms may be necessary. An apprentice is a student who, after completing two terms of work in the College, spends a term in a grade school for observation and practice teaching, under direction. A temporary substitute is a graduate of the College who has not received permanent appointment and may be sent to any school where teachers are absent. The temporary substitute may go to a different school every day. A permanent substitute is a graduate who has not received an appointment as elementary school assistant, but who is assigned to a permanent place in the schools.

In a report of the Superintendent of the St. Louis schools, for 1911 and 1912, Dr. John W. Withers, then President of the Harris Teachers College, says: "A careful study of statistics of failures that occurred in all classes since the College began showed that almost all the failures were made either by those who came from other sources than the St. Louis public high schools, or by those whose record in these high schools placed them in the lowest third of the classes with whom they graduated. For this reason it was decided by act of the Board on May 14th, 1912, to admit to the College without examination, hereafter, only those graduates of the St. Louis public high schools whose record for the high school course placed them within the upper two-thirds of the classes in which they graduated, and to require that all other graduates of our own or other secondary schools should pass an entrance examination covering four years of high school work."

The object of the examination given for entrance to the college is to exclude all persons from the College who do not have scholarship equivalent to that possessed by those in the upper two-thirds of the classes in the St. Louis high schools, and this regulation of the Board of Education was passed because it had been determined that low scholarship in the high school meant low scholarship and failures in the College, and also failure in teaching. If the students, therefore, who have a low scholarship in the high school have a like record in the College, it remains to be determined whether the College and high school records correspond to those made when the student enters upon her teaching career. The following table shows the apprentice record as compared to the College record.

APPRENTICESHIP RECORDS OF 359 GRADUATES

	Excellent	Good	Medium
Management of Children.			
1st Third	65 %	32½%	2½%
2nd Third	42 %	54 %	4 %
3rd Third	25 %	62½%	12½%
Instruction.			
1st Third	65 %	34 %	1 %
2nd Third	46 %	52 %	2 %
3rd Third	19½%	67½%	13 %
Attention to Details of School Business.			
1st Third	92 %	8 %	0 %
2nd Third	86½%	12½%	1 %
3rd Third	57 %	38 %	5 %

"The table shows, for instance, that 65% of the highest third of the group, 42% of the middle group, and 25% of the lowest group won *e.'s* in the management of children. There is even a more marked correlation in the subject of instruction and a less marked, but still a positive, correlation in attention to details of school business."

To take the class of June, 1914, we find the following to be true: "The highest third of the class compared with the highest third of the six preceding classes won an average of 9% more *e.'s* in the management of children, 17% more *e.'a* in instruction, and 2% more *e.'s* in attention to the details of school business; the middle third won 5½% more *e.'s* in the management of children, 2 1-3% more *e.'s* in instruction, and 6 2-3% less *e.'s* in attention to details of school business than the corresponding third of the six preceding classes; the lowest third won 6% more *e.'s* in management, 21½% more *e.'s* in instruction, and 16% more *e.'s* in attention to details than the lowest third of the six preceding classes." Here, then, in the case of even a single class of 58 members we find an interesting, positive correlation between the scholarship record in the College and the judgment of the principals indicating the teaching efficiency of these young women.

But the reader may say that the apprentice record is not a fair comparison and that actual teaching efficiency can not be measured by scholarship rating in that way. Let him consult the following table which gives the record of two hundred ninety-five graduates as temporary substitutes, permanent substitutes, and as teachers.

Temporary Substitutes: 6 Classes—January, 1911, to June, 1913. 295 Graduates

	Management				Instruction				Attention to Details			
	%-E	%-G	%-M	%-U	%-E	%-G	%-M	%-U	%-E	%-G	%-M	%-U
H.3*	38.5	52.3	8.4	.8	29.8	63.9	6.0	.3	54.8	42.4	2.8	.0
M.3*	28.6	60.6	9.5	1.3	21.6	70.6	6.2	1.6	50.1	46.8	2.7	.4
L.3*	25.0	62.8	10.3	1.9	17.8	73.4	7.9	.9	45.9	50.4	3.3	.4

Permanent Substitutes: 6 Classes—295 Graduates

	Management				Instruction				Attention to Details			
	%-E	%-G	%-M	%-U	%-E	%-G	%-M	%-U	%-E	%-G	%-M	%-U
H.3	39.8	51.0	8.0	1.8	36.5	56.7	6.6	.2	64.9	32.7	2.3	.1
M.3	29.3	59.3	10.4	1.0	27.0	65.9	6.5	.6	59.9	37.7	2.4	.0
L.3	23.9	59.9	14.8	1.4	12.8	72.9	12 8	1.5	55.4	40.2	4.4	.0

Teachers: 3 Classes—144 Graduates

	Management				Instruction				Attention to Details			
	%-E	%-G	%-M	%-U	%-E	%-G	%-M	%-U	%-E	%-G	%-M	%-U
H.3	39.1	46.7	12.0	2.2	39.9	50.2	9.5	.4	69.8	28.2	2.0	.0
M.3	40.5	58.1	1.4	0.0	27.0	71.6	1.4	.0	79.9	17.6	3.5	.0
L.3	39.5	57.9	2.6	0.0	17.1	80.3	2.6	.0	78.6	20.0	1.4	.0

*H.3—Highest third: M.3—Middle third: L.3—Lowest third.

The classes are again divided into tertiles according to their relative rank at graduation and the percentage of *e.'s*, *g.'s*, *m.'s*, and *u.'s* won by each tertile in the management of children, instruction, and attention to the details of school business in their work as temporary substitutes, permanent substitutes, and teachers are presented in order. The table compares 17090 markings of principals, 10704 of which were on the service as temporary substitutes of 295 graduates, 5585 on the work of the same group as permanent substitutes, and 801 on the services of 144 graduates (Classes of January, 1911, and June, 1911, and January, 1912) as appointed teachers. The temporary substitutes' service covered a period of 12197 days, the permanent substitutes' 1975 months, and appointed teachers' 196 terms. It will be noted that the percentage of *e.'s* and *g.'s* is very high amounting to 85% or more of all the markings, even of the lowest third of the classes.

There are two respects in particular in which the correlation does not hold in this table, namely, management and attention to detail of school business as teachers. Several causes may be mentioned which will explain the lack of correlation in this particular in this table. First, these markings represent only one and one-half mark per teacher. This means that these marks cover only the first term of teaching for one half and a second term for the other half of the group. Second, no instruction is given in the management of children and attention to details of school business in the College. Third, the young teacher, facing the numerous situations, naturally emphasizes those things she can do best and that is the instruction. Fourth, management and attention to details are more or less matters of routine that the teacher must learn from experience and which she would naturally find irksome until they are routinized. They do not become routinized in the first term. Fifth, and finally, the correlation does hold in later teaching as indicated by data which are not yet in shape for presentation.

The degree of correlation indicated in this study seems to lead to the unmistakable conclusion that scholarship, measured by the standards of the schools, will indicate success in teaching in after life in spite of the numerous exceptions to the rule that lead so often to the erroneous statement that there is no correlation between scholarship and teaching ability. Whether this same degree of correlation prevails in other vocations, we make no attempt to say.

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PROVISION FOR A POST-SENIOR YEAR FOR HIGH SCHOOL SCIENCE TEACHERS

A post-senior year has been provided at the Carnegie Institute of Technology as a part of its professional requirement for those fitting themselves to be teachers of the physical sciences in high schools. About a quarter of the time in this fifth year is devoted to supervised teaching. This practice is given in the institution. A limited number of post-senior students will be paid sufficient for this work to relieve them of the financial burden of the extra year in their course. The plan is somewhat analogous to the hospital service of an interne in the medical profession.

Graduates of other colleges who have taken their degrees in general science and carried some work in psychology or education can usually qualify for the post-

senior year without taking extra courses. At present the outline of the training course provides only for teachers of physics and chemistry, although it is planned later to extend the work to preparation for teaching other sciences. The basis is also laid in education and psychology for advancement to administrative positions since promotion often occurs in this field to a principalship or executive work for those showing the necessary personal traits.

By means of the fifth year of required work the prospective teacher is carried considerably farther in the intensive courses in his particular subject than is possible at colleges which prepare high school teachers with a shorter course. It is believed that this extra training in his science, coupled with the technique of teaching, will equip the science teacher so that he can bring to the high school students the inspiration of the man who knows more than his text. For teaching in college the student is expected to plan for additional graduate years.

Since a large portion of the five-year science teachers' course parallels the four-year preparation for the scientific research option, the graduate is also prepared for positions in government or industrial research laboratories. This research preparation is planned to afford better training for many positions than the regular engineering or liberal arts courses. All general science students study French and German and continue their major science with special instruction in theoretical subjects and laboratory practice to enable them at the time of graduation to undertake immediately many of the problems assigned to physicists or chemists, thus laying a substantial foundation for post-graduate work.

In the bulletin announcing these courses the student is cautioned as to the personal qualifications he should possess. This official description for the vocational guidance of prospective college students is so unusual that it will bear quotation.

"To succeed in the Science Course and in Research, a student should possess unusual ability in Mathematics, Physics, and Chemistry. He must have an interest not only in the practical applications of his major subject, but also in theoretical study and investigation, and should be a student by inclination. He must be patient and painstakingly thorough. If he is also original he should be very successful.

"A student planning to take the teachers' option of this course should, in addition to the above qualifications, possess an attractive personality, teaching ability, and the faculty of clear and forceful expression. He will be more successful as a teacher if he possesses habits of openmindedness, geniality, fairness, and the ability to put himself at the other person's point of view. He should be interested most of all in young men; and to him enthusiasm for his subject and for teaching that subject should outweigh the greater financial attractions of other professions."

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ABSTRACTS AND REVIEWS

DARWIN OLIVER LYON. *Memory and the Learning Process.* Baltimore: Warwick and York, Inc., 1917. Pp. 184. $2.00.

In this work the author discusses the memory problem from its various aspects —giving, however, special attention to its relation to economy in learning, the best form of imagery to be employed for any special task or procedure, and the uselessness of the various "systems" and mnemonic "devices" still so prevalent in our magazine advertisements.

The structure of Dr. Lyon's book, as he himself points out, is somewhat composite—two of the chapters being essentially experimental in character, while the others either deal with conclusions drawn from the data in question or are wholly theoretical in character. The outcome, however, is that he presents a rather complete discussion of the facts of memory and their practical application.

Chapter 1 opens with a discussion of the divisibility of memory—from the view point of anatomy, physiology, and psychology. He then takes up memory in its relation to association and reasoning. This leads him to a discussion of the association of words versus the association of ideas—or, as the author puts it "literal" learning versus "logical" learning. The chapter closes with a discussion of professional and occupational memories—showing the effects of education, environment, sex, race, etc. Following this the author again takes up imagery and endeavors to show that there are as many ways of comprehending as there are forms of imagery.

The main purpose of Chapter II would seem to be to show just *how we learn—how we memorize.* To do this the author takes up one at a time the four sub-factors of memory, retention, reproduction, representation, and identification.

Chapter III is divided into two parts (1) The Distribution of Time in Relation to Economy in Learning and Retention; and (2) The Relation of Length of Material to Time Taken for Learning. Concerning the first of these, it is shown that in estimating *economy*, not only must we consider the *time spent*, but the degrees of *retention* as well. Concerning the second, tables are presented to show that the relation depends almost wholly upon the division of the time in learning, *i. e.* the distribution of the time intervals. This chapter is an exceptionally definite and valuable contribution to educational processes.

Chapter IV is devoted to an extensive inquiry of several memory problems, such, for example, as the relation of quickness of learning to retentiveness. One of the best points brought out by the author is the demonstration of how complex and elaborate any one problem may be, and what a large amount of work must be performed before any approximately correct answer may be given.

The popular impression among the laity is that the slow but steady worker, even though dull, remembers his work better and longer than the more brilliant student, —a corrollary of which is that those who learn the quickest forget the quickest. However, in so far as reliable statistics have been gathered it has been found that in general the most rapid learner is also the best retainer. A complete expression of the various results obtained with the various methods and materials is obviously impossible in this brief summary. Generally speaking, we may say that those who learn quickly remember longest if the material memorized is "meaningful" or "logical" but that they forget quickly if the material is such as involves the memorizing of motor associations, as is generally the case with digits, words, and nonsense syllables.

As to economy in learning the author shows that before this problem can be intelligently discussed one must first define exactly what he means by "economy." In short, Dr. Lyon shows that to commit to memory is nothing but to make the acquired idea as capable as possible of reproduction; not only that it may be easily and faithfully reproduced but that its relationships may be many and varied, *i. e.* that it may be reached from many sides and through different channels and ideas. The author points out that in every day life not only a one-sided but a many-sided power of recall is demanded. Hence it follows that if a certain method of memorizing results in a more-sided power of recall, this method will deserve more credit than one that secures merely a one-sided reproduction.

The author points out that no determination of economy in any one method can have universal validity, for the reason that the purpose that the learner may have in view differs in various cases. For example, one method may lead rapidly to an errorless first recitation but the permanence of the retention may be low; another method, on the other hand, may lead much less rapidly to a first errorless recitation, but the retention secured by it may have a high degree of "permanicity." In short, economy of learning depends upon the purpose or result desired by the individual doing the learning in question. Hence if any one included in his meaning of memory some certain method, *i. e.*, emphasis on the state of health and mental condition of the individual at the time of his memorizing, the various other methods would for the purpose of discussion remain unused.

Concerning the educational value of psychological research, it is impossible in this space to give a connected and complete account of Dr. Lyon's opinion. As a piece of literature alone this chapter ranks high both because of the felicity of the style and the matter-of-fact and practical argument presented. In some respects it represents the most important contribution of the volume. At first sight it may impress the reader as a criticism—and a rather harsh one—of experimental psychology in general, but closer analysis will show that as a matter of fact the experimental psychologist is here defended and praised. There is also an interesting discussion on mnemonics, showing that on the whole they are of little value.

Taken as a whole this chapter presents us with the most comprehensive discussion of the relation that experimental psychology bears to education that has appeared recently. It will be seen that Dr. Lyon, though thoroughly trained in the Herbartian psychology and pedagogy, does not regard them as the consummate formulation of educational theory. He considers it necessary to supplement Herbart by a more practical knowledge of experimental psychology in its bearings on education. He seems to think that much of the work performed in the psychological laboratories is time wasted, yet he tells us that the educator can not get along without the psychologist, and it is evident that he desired to win for exact psychology a greater amount of attention and interest from pedagogy. It may appear that the author is somewhat too harsh in his criticism of the "results obtained by the experimental psychologist," but there remains ground for abundant praise of the chapter in question, as well as of the work as a whole.

The book is fairly well printed and carries an index of authors as well as a carefully prepared subject index. There are 30 tables (including those in the Appendix) and in the pocket in the front cover are nine large plates in two colors. Many of these plates would be in more convenient form if they had been reduced in size and included in the regular binding of the book.

J. V. BREITWIESER.

Colorado College.

HAROLD O. RUGG. *Statistical Methods Applied to Education.* Riverside Textbooks in Education. Boston: Houghton Mifflin Co., 1917. Pp. xviii, 410. $2.00.

What Horace Mann did in 1843 for educational statistics Rugg now has done in 1917. Over half a century ago the need for a quantitative expression of educational conditions made itself felt. But it was not without a great deal of general opposition that Mann was able to accomplish what he did. At the present time, however, we find school people, with few rare exceptions, more than favorable to a statistical treatment of educational facts. Indeed that administrator who has no need for refined methods of evaluating school results is as difficult to find as the now famous needle in the haystack. The book fills a long felt need, and will undoubtedly help trace a new high-water mark in education.

The plan and purpose of the book is outlined in the preface. Rugg has assumed "that it is necessary to equip school men, generally, with a thorough-going knowledge of statistical methods; that in order for them to be discriminating in the use of the various methods in improving their school practice, this large background of knowledge must be developed; and that it is possible to explain rather completely the reasons for and the significance of the principal statistical devices without expressing the explanation in technical mathematical language." When the student turns the last page of the book he is convinced that Rugg has made these statements good.

The first three chapters of the book are devoted to a discussion of the statistical methods in education, the collection of educational facts, and the tabulation of educational data. A brief survey is made of recent quantitative educational literature and its importance is emphasized in the light of administrative and pedagogical-experimental problems. The necessary steps in educational research are then outlined, and the sources for the collection of data indicated. These sources have now been amply supplemented by the author in the current numbers of "The School Review" and "The Elementary School Journal." It is also gratifying to find a very critical presentation of the importance of the questionnaire, and the guiding principles which should underlie its preparation. Questions relating to various methods of tabulation are discussed, and a brief description of the Hollerith system is given. One regrets finding no mention of the excellent Findex system, nor of some of the other labor saving devices, such as the slide-rule, comptometer, Brunsviga, space probably being prohibitive.

The next three chapters initiate one into the statistical treatment of educational data. The frequency distribution, the method of averages and the measures of variability are discussed. The terms "unit," "scale," "frequency," "class interval," etc., are explained and illustrated. The chapter on averages is a very valuable one, especially because of the emphasis on uniform terminology and the discussion concerning the relative merits and demerits of the various averages. The reviewer has not been convinced however, that to calculate the median, $\frac{N}{2}$ should be used in preference to $\frac{N+1}{2}$. In view of Meitzen's discussion this change might lead to erroneous results when interpolating (by formula) the values for the different cases in a given class interval. Two of us are now at work on this problem and our results will be published shortly. In stating the formula for the harmonic mean Rugg gives the one most commonly used,

$$\frac{1}{H} = \frac{1}{N}\Sigma\left(\frac{1}{m}\right)$$

The reviewer has simplified this formula:

$$H = \frac{N}{\Sigma\left(\frac{1}{m}\right)}$$

thus facilitating its understanding and computation. The chapter on the measure of variability is an excellent illustration of how an apparently difficult subject matter may be clearly explained if only the author take sufficient pains to think and write plainly and succinctly. The average deviation, the standard deviation, the quartile deviation, the probable error, the semi-interquartile range, the various coefficients of variation and of skewness are interpreted in the light of the normal frequency surface and their calculation illustrated. It seems to the reviewer that it might have been well to indicate that for few cases the standard deviation should be calculated from the formula:

$$\sigma = \sqrt{\frac{\Sigma f d^2}{N - 1}}$$

according to the method of least squares, and under coefficients of variability a consideration of the formula:

$$\text{C. V.} = \frac{Q_3 - Q_1}{Q_3 + Q_1}$$

would have added to the value of the paragraphs dealing with those specific items.

In the next two chapters the normal frequency surface and the use of the normal frequency curve in education are considered. In using the book with students one misses a discussion of the ogive and its relation to the normal frequency surface. Especially is this true in connection with a study of percentile grading. And here, if I may be permitted to digress, a good portion of the recent work with percentiles is invalid because the ogive and not the frequency surface has been utilized as the base of reference. The major portion of the chapter is devoted to probability, and every bit of it is worth while, since probability is the foundation upon which our whole statistical structure is based. As homely as the comparison may appear, it may be said with justice, that every statistical problem in education brings us back to the question of "tossing pennies." The chapter on the use of the normal frequency curve in education is replete with applications to everyday school problems.

Chapter IX is devoted to a consideration of the measurement of relationship, or correlation. The various methods are indicated and practical applications made. Galton's graphic method, the Pearson coefficient by the long and short methods, the Spearman foot-rule and rank differences formulae, the Pearson *eta* method, the four-fold table, unlike signs and contingency methods are all given. No mention is made of Yule's recent improvement of his Q method. His present coefficient of colligation (ω) is superior to some of the other "association" methods, and far easier to compute. The regression coefficient and the regression equation, their meaning and significance are explained. In the discussion of non-linear regresssion only one of the *etas* is mentioned, η_y, nothing being said regarding the other *eta*, η_x, which is equally important. Thus in one of W. Brown's articles (Brit. J. Psychol. Vol. 6,

p. 236–237), the Pearson coefficient is $+.033\pm.030$, *eta y* is $+.323\pm.027$, and *eta x* is $+.182\pm.029$. This fact should be taken into account when using Blakeman's test for linearity. No space is given to Spearman's correction formula, Rugg being skeptical as to its value. He would be inclined to agree with those who maintain that by making measurements more efficient, correction will be unnecessary. But how can we tell whether measurements are really efficient unless we use a correction formula? To quote Spearman, "The suggestion is like telling a man to brush his coat until it is clean but never look whether it is so." The corrected coefficient is especially necessary when attempting to find the true probable error of a correlation coefficient. True P. E. $= \frac{\text{P. E.}\, r \times r_{pq}}{r}$. These remarks, however, are not meant to detract from Rugg's very masterly presentation of the measurement of relationship, for he has crowded within a comparatively few pages material which is practically inacessible to the average school man.

The last chapter of the book is in many respects its most unique feature. Everyone interested in "getting facts across" should not fail to read these valuable pages. Figures mean nothing to the statistically uninitiated unless presented in graphic form. These fifty pages are a gold mine of illustrative material.

Other features of great value are a tabular review of quantitative studies on school administration, together with a bibliography of 165 titles, brought to date; a selected bibliography on statistical methods; a set of illustrative problems at the end of most of the chapters; a summary of formulae and symbols used in the text; and ten tables to facilitate computation. There are several typographical errors in the text and tables which a revised edition will eliminate.

The editor of the Riverside Textbooks in Education has not in the least overdrawn the merits of the book when he stated that "The volume represents a very successful attempt to produce a book which will apply the mathematical theory of statistical work to educational problems, and as such it should find a hearty welcome from the teachers of education in universities, colleges, and normal schools, educational investigators generally and school officials interested in making the best of statistical data and displaying the results to their supporting public in the most effective graphic form."

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Stanford University.

The Journal of Educational Psychology

INCLUDING EXPERIMENTAL PEDAGOGY, CHILD PHYSIOLOGY AND HYGIENE, AND EDUCATIONAL STATISTICS

Published monthly except July and August by

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The price of the JOURNAL is $3.00 per year of ten monthly issues, if paid in advance. Single issues are 50 cents each. Back volumes are $3.50 in original wrappers and $4.75 bound in library buckram. Foreign postage is 20 cents extra for Canada and 30 cents for other countries in the Postal Union.

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VOLUME IX APRIL, 1918 NUMBER 4

EDITORIAL

Science and Sentimentality

In this day when nations are pouring out their life blood on the battle-field without stint, when we ourselves are sending millions to the front, when our friends and relatives are suffering from wounds and disease, it would seem that every sane individual would welcome and eagerly further any investigations of scientific men to better understand and cope with the problems of healing. Yet, such is the perversity of human nature, a certain class of intellectual people are doing their utmost to hinder scientific experimentation to facilitate the treatment of wounds and disease. This malevolent influence has recently shown itself in the endeavor to block the American Red Cross in its appropriation of funds for "experimentation upon living animals for the purpose of finding methods of prevention and remedies for new and strange diseases among soldiers." "This money," says the general manager of the Red Cross, "was used for the direct and immediate purpose of finding ways to prevent or cure wounds and sickness among American soldiers. It develops, however, that there are large numbers of earnest Red Cross members who have

sincere convictions against the use of animals for discovery of remedies for sickness. We recognize that it should be an obligation of the Red Cross management to show deference to such honest conviction." Fortunately a private individual offered to supply the necessary funds for carrying on this work, and to reimburse the Red Cross for the money already spent. "The War Council," continues the manager, "decided to accept this offer without in any way taking a position either for or against the question in controversy, but because they do not wish their acts to be considered in conflict with the sincere convictions of Red Cross members."

It is with great pleasure that we quote the following paragraphs from an editorial article in the *New York Times*.

"It will be with regret deeply tinged with indignation that all sane and reasonably enlightened people will hear of the decision by the heads of the Red Cross not to use for animal experimentation—often and almost always incorrectly called 'vivisection'—the money hitherto appropriated by them for that purpose. The decision may mean avoiding the loss of a few contributions to the Red Cross funds, but it also means the triumph of vicious ignorance over common sense, and it will encourage to further efforts the members of the most detestable and not the least dangerous group of men and women to be found in the United States.

"And the Red Cross cautiously says that it does not take sides for or against 'vivisection!' Such caution is reprehensible—is utterly unworthy of that great and beneficent organization. It should take sides, standing for right and against wrong. The immediate profit of doing anything else or less will be dearly bought in future loss of both money and respect. Red Cross money, in the amount that was proposed, could not possibly have been better invested than in the establishment of a biological laboratory near the scene of war for the study of the maladies of soldiers which this sort of research has not yet conquered. It was weak, and worse than weak, for the Red Cross to heed the hysterical shrieks and the monstrous charges of venality and murder that came from a few people whom it strains charity to call deluded or insane."

It would seem that the chief instruments in this obscurantist campaign are the *Christian Science Monitor* and certain individuals prominent in that organization. From people who deliberately disregard the facts of experience, and who express a profound contempt for medical science and natural science of all kinds, nothing more is to be expected. But the sinister aspect of the whole affair is the influence that these people are able to exert on such a respresentative organization as the Red Cross. This is only possible because of a widely spread mushy sentimentalism for animals, which has been fostered by many agencies, one of which is the school. Many times as much effort is devoted in the schools to arousing in pupils the emotion of sympathy for animals as to awakening a whole-hearted appreciation of and enthusiasm for the beneficent effects of biological and sanitary science. Not that pupils should be less humane but that a better and more effective type of humaneness can be attained through an understanding of the benefits of science. In the present crisis it is the duty of every scientific man to uphold the standards of scientific investigation with all the zeal of a religion, and to see to it that his influence is used to the utmost to stamp out any such pernicious and unpatriotic sentimentalism as that which brought pressure to bear on the Red Cross. J. C. B.

NOTES AND NEWS

The matter of the reorganization of education in England moves slowly forward, but not entirely to the satisfaction of those who are zealous for a greater amount of attention to science. Sir Ray Lankester has recently published an article commenting on the report of the government committee regarding the position of science in secondary schools and universities. He welcomes the proposal of the committee to secure equality of opportunity to all branches of learning, but objects to turning the administration of education back to the schools and universities as now organized. "The Committee," he says, "instead of rescuing education from the professional vested interests of the classical schoolmasters, hands back the victim, after many professions of good-will, to the tender mercies of those who are banded together to starve, torture and discredit her, and remorselessly to maintain the domination and the pecuniary allurements of the 'classical system.' "

The American Association of Clinical Psychologists was organized at Pittsburgh, on December 28, 1917. The membership includes men and women holding the doctorate in psychology, who are engaged in the clinical practice of psychology in the United States. The forty-five charter members are chiefly directors of clinics, of bureaus of child welfare, of institutional laboratories; engaged in army service, as mental examiners of recruits; or connected with courts, hospitals and schools. The objects of the Association are to promote an *esprit de corps* among psychologists who have entered the practical field, to provide media for the communication of ideas, to aid in establishing definite standards of professional fitness for the practice of psychology, and to encourage research in problems relating to mental hygiene and corrective education.

The Council of the Southern Society for Philosophy and Psychology has decided, on account of the general situation and of the number of members of the Society who are engaged in various forms of national service, to abandon the annual meeting scheduled to be held at Peabody College, Nashville, this spring.

At the meeting of the New York Branch of the American Psychological Association, April 22, 1918, the following papers were presented: "Mental Effect of Outdoor versus Indoor School Life," by W. A. McCall; "Vocational Tests for Retail Saleswomen," by Elsie Oschrin; "Study of Three Cases of Special Disability in Reading," by Sarah Fisk; "Transfer of Habits in the White Rat," by H. A. Ruger; "Notes with Illustrations Showing the Development and Application of a Child's Number Interest," by the Child's Mother.

The Carnegie Institute of Technology announces ten graduate fellowships and assistantships in salesmanship research and in lines

of non-selling work in department stores. These positions not only yield a handsome stipend to the holders, but carry with them unequalled facilities for study in vocational guidance. Furthermore, in order to encourage young men and women to enter the filed of vocational education as teachers and supervisors about twenty $500 scholarships will be provided for the most capable seniors and juniors who present themselves for this work.

Announcement is now made that Dr. Guy Montrose Whipple has resigned from the University of Illinois in order to accept permanent appointment to the faculty of the Carnegie Institute of Technology as professor of applied psychology and director of a new bureau of educational research. In this capacity as director of educational research, Dr. Whipple will carry forward scientific studies in engineering and technical education, including problems of curriculum, methods of instruction, selection of students, and the like. Dr. Whipple will continue to serve as acting director of the bureau of Salesmanship Research as long as Dr. Scott continues to be engaged in war work.

Dr. James Burt Miner is acting as head of the Division of Applied Psychology at the Carnegie Institute of Technology during the absence of Dr. W. V. Bingham on war work in Washington. Announcement is made of Dr. Miner's promotion to the rank of associate professor.

Dr. L. L. Thurstone has been advanced to the rank of assistant professor at the Carnegie Institute of Technology.

Dr. A. J. Beatty, assistant to the director of the Carnegie Bureau of Salesmanship Research, will on June 1st become director of education of the American Rolling Mills Company at Marietta, Ohio.

Dr. Kate Gordon has been granted leave of absence from the Carnegie Institute of Technology for the fall quarter to enable her to carry out for the California State Board of Control a psychological investigation of the children in certain of the state institutions.

Dr. Beardsley Ruml has been given leave of absence from the Carnegie Institute of Technology to devote his full time to the direction of the work of the Trade Test Standardization Division of the Committee on Classification of Personnel in the Army. Dr. L. L. Thurstone has been granted half time leave for similar work. Dr. T. J. Kirby has been granted half time leave from the University of Pittsburgh and is working with Dr. Thurstone, Mr. L. C. Toops of the University of Ohio, and Dr. J. Crosby Chapman who is in charge of the Pittsburgh station of this Trade Test Standardization Committee. The purpose of the development of these standardized trade tests is not to discover which trade or occupation a soldier should be trained to follow. It is rather to measure the degree of

trade skill which he already has. The question is not one of "guidance" but of assignment of men to those duties of a technical sort which their civilian occupations have equipped them to follow to advantage in the army. Oral and performance tests of carpenters, pattern makers, vulcanizers, automobile engine repairmen, truck drivers, electricians, etc., have been developed, standardized and introduced into army procedure. Tests for skill in more than a hundred other trades of importance in a modern army remain to be developed and standardized. About twenty mechanical engineers, civil service experts, employment managers and psychologists are engaged in the preparation of these trade tests, working under the immediate supervision of Dr. Ruml at Newark, New Jersey, and under the more general direction of Dr. Bingham who is executive secretary of the Committee on Classification of Personnel in the Army, with headquarters in the office of the Adjutant General at Washington.

Professor E. A. Kirkpatrick, of Fitchburg, Mass., announces that he is now able to supply to psychologists and educators pictures of Professor John Dewey. He has been able to furnish pictures of other leaders in education for some time, but has had to disappoint the many inquirers for Professor Dewey's picture.

Mr. Murray Dalman, assistant principal at Emmerich Manual Training High School, has been appointed director of a department of educational reference and research recently created at Indianapolis.—*School and Society.*

L. O. Smith, a graduate student in education and psychology at the University of Iowa, has been selected as director of educational research in the Omaha schools.

Dr. Buford Jennette Johnson, Ph.D. (Hopkins '16), has resigned her position as assistant psychologist in the Laboratory of Social Hygiene, Bedford Hills, N. Y., and has accepted an appointment as research assistant in the Bureau of Educational Experiments, New York City.—*Science.*

Harold Ernest Burtt has been appointed instructor in psychology at Harvard University.

PUBLICATIONS RECEIVED

THOMAS ALEXANDER. *The Prussian Elementary Schools.* New York: The Macmillan Company, 1918. Pp. viii, 571. $2.50.

It is desirable to understand one's enemy, and no one can understand the German people who fails to take account of the German schools. Much has been written of the German higher schools, but these are intended only to increase the efficiency of the upper classes. The Germans, more than any other people in history, have used their elementary schools to develop a unified and solidified public sentiment for the support of a definite type of government and a specific national ideal. The aims of German elementary education and the detailed procedure by which these aims have been realized are admirably set forth in the present valuable book. "The elementary schools of Prussia have been fashioned so as to make spiritual and intellectual slaves of the lower classes . . . . . The Prussian elementary school is the best in the world from the point of view of the upper classes of Germany. From the point of view of the lower classes it is the worst system, for it takes from them all hope of improving their condition in life." The first twelve chapters of the book give a clear and accurate account of the more general features of Prussian schools, such as their development, administration, school attendance, school management, preparation, salaries and pensions of teachers, and the organization and courses of study. The remaining sixteen chapters deal with general and special methods of instruction and the organization of subject matter in religion, mother tongue, mathematics, history, geography, natural sciences, domestic economy, singing and drawing, and manual and physical training. The book will unquestionably take its place as the standard authority on the subject.

J. MACE ANDRESS. *The Teaching of Hygiene in the Grades.* Boston: Houghton Mifflin Company, 1918. Pp. xii, 177. $0.75.

Sane and normal living is one of the most important ideals of education, yet it is only in recent years that much attention has been paid to hygiene in the elementary schools. This little volume gives an excellent statement of the arguments for the emphasis of hygiene in elementary education, shows how far from satisfactory is the present status of the subject, indicates goals of instruction, makes valuable suggestions on methods of teaching, and discusses several important problems in hygiene. Among the latter are alcohol, tobacco, colds, tuberculosis, cleanliness, exercise, care of the teeth, proper foods, pure milk, elimination of waste, care of the eyes, care of babies, sex hygiene, the house-fly, the mosquito, the cat, rats and mice, and the prevention of fires and accidents. There are references to standard books under each topic.

FRANK W. BALLOU. *Arithmetic. The Courtis Standard Tests in Boston, 1912–1915. An Appraisal.* Boston Public Schools, Bulletin No. 10 of the Department of Educational Investigation and Measurement, 1916. Pp. 48. Seven cents.

In those schools where standard tests have been given regularly the pupils show as much as seventeen per cent. superiority over pupils who were tested for the first time. The pamphlet gives valuable norms and suggestions for procedure.

JOHN M. BREWER. *The Vocational-Guidance Movement: Its Problems and Possibilities.* New York: The Macmillan Company, 1918. Pp. xi, 333. $1.25.

This is a thoughtful and scholarly consideration of a very important subject. The author surveys some of the problems of vocational guidance, traces the history of the movement, shows its relation to educational guidance, points out many of the pitfalls into which advocates of guidance have fallen, and outlines a program for its development. He is extremely skeptical regarding the value of psychological tests in vocational guidance, and subjects to very shrewd criticism the proposals of Muensterberg, Lough, Scott and others to determine capacities by responses to artificial situations. This effort he thinks is the result of looking upon capacities as fixed entities, which is a survival of the old "type" or "faculty" conceptions in psychology. All that vocational guidance can do is to secure a rational type of school, to bring teachers into sympathetic contact with the inner lives of their pupils, to co-operate with the child in choosing and starting in a life career, to endeavor to improve the conditions of employment, to stimulate the child's interest in his career and help him see its opportunities, and to give him such training in his chosen occupation that he may work to his own best advantage. While the author may be unduly pessimistic about the outcome of psychological and educational tests, his strictures deserve careful consideration, and the general tone of his book is sound and salutary.

CATHERINE C. CONWAY. *Performance Norms for Thirteen Tests.* New York State Board of Charities. Eugenics and Social Welfare Bulletin, No. viii, 1917. Pp. 142.

The tests studied in this monograph are the Knox cube, number cancellation, recall of objects, grouping of objects, peg design, story reproduction, syllogisms, detail drawings, balance nickel, peg board, tower, and boat. The total number of children examined was 757.

JOHN EDGAR COOVER. *Experiments in Psychological Research at Leland Stanford University.* Leland Stanford Junior University Publications, Psychical Research Monograph No. 1, 1917. Pp. xxiii, 641. $3.50.

This stately volume represents the first fruits of the Stanford $50,000 fund for the investigation of spiritualism and allied psychic phenomena. The attitude assumed by the investigator is one of strict scientific inquiry, and an attempt has been made to subject certain occult phenomena to experimental scrutiny. The first topic, thought-transference, is discussed from a theoretical point of view, and experiments on guessing of numbers, guessing of playing cards, and the "feeling of being stared at" are reported. Other topics considered are experiments on subliminal impression, mental habit, experiments in sound assimilation, and investigations of pseudo-prophecy, automatic writing, and long-distance thought-transference. The conclusions negative any mystical assumptions, but bring out some interesting phases of human mental processes.

GEORGE S. COUNTS. *Arithmetic Tests and Studies in the Psychology of Arithmetic.* Chicago: University of Chicago Press, 1917. Pp. iv, 128. $0.75.

This monograph presents a detailed study of the results of the surveys of the Cleveland and the Grand Rapids schools, so far as the arithmetic was concerned. Fifteen tests, constructed on the basis of the Courtis Tests, but involving a greater

variety of situations, were given to 834 classes in grades III to VIII. The data are organized under general results, types of errors, age groups, promotion groups, and race groups. The types of errors afford interesting material for the teacher.

ISOBEL DAVIDSON. *Real Stories from Baltimore County History.* Baltimore: Warwick and York, 1917. Pp. 282. $1.00.

Local history, as well as local geography, is now advocated for the grades, and the present book is the result of a remarkably successful effort to form a collection of local history stories by pupils and teachers. The stories fall into three groups, the early pioneer days, the colonial days, and the time from the stage-coach days to the present. Teachers will find this book interesting and suggestive not only for the material it contains but also as a model for similar local collections.

KARY C. DAVIS. *School and Home Gardening.* Philadelphia: J. B. Lippincott Company, 1918. Pp. xvii, 353. $1.28.

This splendidly illustrated manual will be of great value to those who are directing or planting school or home gardens. There are chapters on planning the garden, tools, soil, germination, drainage, vegetable and flower gardens, trees, and vines, a garden calendar for northern and for southern states, and suggestions for club work and garden contests.

JAMES FAIRGRIEVE. *Geography and World Power.* New York: E. P. Dutton and Company, 1917. Pp. viii, 356. $1.50.

Man boasts that he has triumphed over nature, yet it is nature that makes man's very existence tolerable. Throughout the world's history national power has been gained only through utilizing the forces of nature. The author shows that from the time of the Egyptians to the present day national power has depended on geographical factors, and it is incumbent upon us to realize what the favorable factors are and to make the best possible use of them. It is a most interesting book.

FREDERIC HENRY GERRISH. *Sex-Hygiene: A Talk to College Boys.* Boston: Richard G. Badger, 1917. Pp. 51. Sixty cents.

This is a lecture on sexual continuence that has for many years been delivered annually before the freshman class of Bowdoin College. The dangers of venereal disease are portrayed, and ideals of purity and self-control are urged.

JOHN M. GREGORY. *The Seven Laws of Teaching.* Boston: The Pilgrim Press, 1917. Pp. xii, 129. Seventy-five cents.

This little book by the founder of the University of Illinois is presented in revised form by Dr. W. C. Bagley and Warren K. Layton, of the School of Education of that institution. It sets forth with luminous clarity and vigorous directness those essentials of teaching which have stood the test of the most rigorous psychological criticism. It would be difficult to find so much sound wisdom packed away in such small compass.

HERBERT S. JENNINGS, JOHN B. WATSON, ADOLF MEYER AND WILLIAM I. THOMAS. *Suggestions of Modern Science Concerning Education.* New York: The Macmillan Company, 1917. Pp. vii, 211. $1.00.

The four addresses here presented give us the reactions of the specialist in biology, psychology, psychopathology and sociology to fundamental questions in education.

Professor Jennings makes a serious arraignment of present school practices from the point of view of the welfare of the race, and sounds a call for greater attention to and study of school conditions. Professor Watson tells of his experimental studies of infants, and pleads for a closer connection between the laboratory and the school. Professor Meyer urges a greater individualization of the instruction to prevent the nervous breakdowns which are all too frequent, and Professor Thomas emphasizes the need for a science of social behavior to furnish a basis for educational proeedure. The book is tremendously stimulating, and deserves wide and thoughtful study.

PERCY GAMBLE KAMMERER. *The Unmarried Mother: A Study of Five Hundred Cases.* Boston: Little, Brown and Company, 1918. Pp. xv, 342. $3.00.

Self-control in sex relationships is generally considered one of the most important topics in moral education. Latterly society is beginning to inquire as to its responsibility for the upbringing of the illegitimate child. The conditions brought about by the war have intensified interest in both of these topics. In the present book we have a detailed, first-hand study of the conditions which lead women to become unmarried mothers. The author recommends laws for the protection of mentally abnormal women; laws for the better care of the child; improvement of recreational facilities; and a more rational teaching in regard to sex hygiene.

STERLING ANDRUS LEONARD. *English Composition as a Social Problem.* Boston: Houghton, Mifflin Company, 1917. Pp. xiii, 202.

The principal suggestions in this book in regard to teaching English composition are the idea of the social character of the composition, such handling of organization problems that children's minds will work best in mastering them, and the distinction between matters to be fixed as habits and those to be developed through conscious reflection. The whole aim is to ensure expressional skill in children, and the author's methods will command the unqualified approval of the psychologist.

RICHARD SWAN LULL. *Organic Evolution: A Text-book.* New York: The Macmillan Company, 1917. Pp. xviii, 729. $3.00.

This is a magnificently complete, thorough, authoritative account of the evidence for the evolution of animal life drawn especially from fossil remains. The book is the outgrowth of a series of lectures which has been given annually to students of Yale University for more than ten years. In it the author discusses the history of the evolutionary idea, the distribution of animal life, the various theories of the mechanism of evolution, and the evidences of evolution derived from the life cycle of animals, from adaptations to their environment, and from the records left by organisms in the various geological strata. It is a useful and comprehensive handbook for all questions connected with evolution.

STEWART MCDOWELL. *Seven Doubts of a Biologist.* New York: Longmans, Green and Company, 1917. Forty cents.

In this little book the author, who represents himself as a trained biologist, takes up one after another the religious doubts that are supposed to be raised by the study of modern biology. It is to be feared that the author merely knocks over a man of straw, for either the doubts are not fairly stated, or they are answered by such inconclusive arguments as would have little weight with any open-minded doubter.

C. R. MAXWELL. *The Observation of Teaching.* Boston: Houghton Mifflin Company, Riverside Educational Monographs, 1917. Pp. xi, 120. $0.75.

This monograph is designed as an aid for students in training and for all who are interested in analyzing the teaching process. To get adequate value from observation of teaching one must have a clear idea of what to look for. To this end the author outlines the desirable characteristics of the teacher, the appearance and attitude of the pupils, the procedure in various types of lessons, and the physical features of the schoolroom. The practical difficulty with this scheme is that it is too bulky to be readily applied.

Mental Examinations. Eugenics and Social Welfare Bulletin, No. 11, New York State Board of Charities, 1917. Pp. 73.

There is an account of the examination of 2,142 orphan asylum children, 607 delinquent girls, 183 reformatory women and certain classes of school children by the Binet tests, and the re-examination of 37 children ten months after the first examination.

IRVING ELGAR MILLER. *Education for the Needs of Life. A Textbook in the Principles of Education.* New York: The Macmillan Company, 1917. Pp vii, 353. $1.25.

This book is the outgrowth of the author's "Psychology of Thinking." The biological point of view is emphasized throughout, and the attempt is made to interpret the meaning and aim of education in terms of individual and social values, to trace the essential steps in the development of the child, to apply the ideals of individual and social needs to the construction of the curriculum, to formulate principles of method on the basis of the child's self-activity, and to point out the functions and qualifications of the teacher. The book is not profound, but it is well-conceived, and takes account of the best and most recent educational literature.

WALTER SCOTT MONROE. *Development of Arithmetic as a School Subject.* Washington: Bureau of Education, Bulletin, 1917, No. 10. Pp. 170. Twenty cents.

This is a careful and authoritative study of the history of the teaching of arithmetic in American schools. The earliest accounts of arithmetic in the colonies are recorded, the texts of Dilworth, Pike and Adams are analyzed, the cyphering methods are described, Warren Colburn and the Pestalozzian influence are discussed, and the host of more recent arithmetics from Emerson, Davies and Ray to the experimental studies of Rice, Stone and Courtis receive adequate attention. It is an admirable piece of work, and deserves the widest circulation.

WALTER S. MONROE, J. C. DEVOSS AND F. J. KELLY. *A Teacher's Handbook on Educational Measurements, Reading, Writing and Arithmetic.* Kansas State Normal School: Studies by the Bureau of Educational Measurements and Standards, No. 5, 1917. Pp. 66.

This is a preliminary survey of the recent experimental work in the school subjects mentioned, and was intended for local distribution. The work has been expanded and published under the title of "*Educational Tests and Measurements*" by Houghton Mifflin Company.

MARGARET B. OWEN. *The Secret of Typewriting Speed.* Chicago: Forbes and Company, 1917. Pp. 158. $1.00.

The author of this book is said to have won the world's typewriting speed championship four times, and the last time to have written 143 words per minute for an hour. It would be extremely interesting if she could tell how she did it, but she cannot, or at least has not done so here. The book contains much good practical advice to the typewriter, and will undoubtedly be of service to those specializing in this field.

JOHN FRANKLIN REIGART. *The Lancasterian System of Instruction in the Schools of New York City.* New York: Teachers College, Contributons to Education, No. 81, 1916. Pp. v, 105. $1.25.

Perhaps the most valuable portion of this interesting study is the chapter on the method of teaching which Lancaster employed in the instruction in specific school subjects. The chapter on the organization and administration of the monitorial schools, and that on moral and religious training throw much light on the New York Free Schools in the early half of last century.

CHARLES L. ROBBINS. *The School as a Social Institution, An Introduction to the Study of Social Education.* New York: Allyn and Bacon, 1918. Pp. xxv, 470.

It is generally recognized that the social aspects of education need greater emphasis and more consistent attention, but one difficulty heretofore has been the lack of suitable treatises on the subject. The present volume will contribute to removing that lack, and should receive wide-spread consideration. Among the topics treated are the evolution of the idea of the school as a social institution, social ideals and conditions affecting the school, reaction upon society, health protection and the schools, the selection of the socially fit, vocational and educational guidance, the moral significance of the schools, community centers, the social elements in the curriculum, social aspects of method, and the recruiting of teac ers as a social problem. The treatment of these topics is sympathetic and progressive and the book points to the greatly increased usefulness of the schools.

BERTRAND RUSSELL. *Political Ideals.* New York: The Century Company, 1917. Pp. 172. $1.00.

A collection of essays on topics of social import. The first, which gives the title to the book, examines the foundations of government, and points the way to a world democracy. Others are concerned with capitalism, pitfalls in socialism, individual liberty and public control, national independence and internationalism. Throughout the discussion the author seeks the greatest individual liberty with the greatest advantage to the common weal.

CARL E. SEASHORE, Editor. *University of Iowa Studies in Psychology. No. VII.* Psychological Monographs, Vol. 25, No. 2, 1918. Pp. 163.

The most significant paper for the educational psychologist in this collection is that on "Correlation of Factors in Musical Talent and Training" by Carl E. Seashore and George H. Mount. In this the authors bring together materials which have been collected in the Iowa laboratory for the past ten years regarding tests of musical ability, and endeavor to determine statistically the relationship between the various tests that have been employed. This is a most important discussion of the

fundamentals of musical testing, and can be cordially commended to the attention of all those who are interested in tests of any sort. The highest correlation (.61) was between singing interval and singing keynote. The highest correlation between pitch discrimination and fourteen tests was that with tonal imagery (.52).

HENRY LESTER SMITH. *A Survey of a Public School System.* New York: Teachers College, Contributions to Education, No. 82, 1917. Pp. xii, 304.

A detailed account of a school survey of Bloomington, Indiana. In the chapter on the achievements of pupils, to which over one hundred pages are devoted, we have scores on the Stone, Courtis, Haggerty and other tests in arithmetic; handwriting measured by both the Thorndike and the Ayres scales; the Rice, Courtis, and Buckingham tests in spelling; the Courtis Standard Tests in Composition, scored by the Hillegas scale; drawings scored by the Thorndike scale with the Childs extension; and reading scored by the Thorndike scales. In many respects this is the most scientific of school surveys.

FRANK N. SPINDLER. *The Sense of Sight.* New York: Moffat, Yard and Company, 1917. Pp. xv, 156. $1.25.

This is one of the books in the series entitled "Our Senses," edited by Professor George Van Ness Dearborn. It purports to give a popular account of the facts of vision. There is a real need for such a book, but in it one expects a reasonable completeness and accuracy of statement, and in both respects the present volume leaves something to be desired. There is no discussion of the chief visual defects, the figures are misleading, and much emphasis is laid on the generally discredited theory of visual types. It is to be hoped that other volumes of the series will be more scientific.

LINA ROGERS STRUTHERS. *The School Nurse.* New York: G. P. Putnam's Sons, 1917. Pp. xiv, 293. $1.75.

There is a growing recognition of the school as an important agency of social betterment, and one of the most potent faos in this activity is the school nurse. The present volume by the former superintendent of school nurses of New York City will be of value to school nurses, teachers, and especially to parents. There is a history of the school nurse movement, plans for the organization and administration of school nursing, school clinics, children's diseases and their treatment, common physical defects, decayed teeth, and the qualifications of the school nurse. The book is a distinct contribution to an important phase of school service.

E. H. STURTEVANT. *Linguistic Change. An Introduction to the Historical Study of Language.* Chicago: The University of Chicago Press, 1917. Pp. x, 185. $1.00.

This is a delightful and informing little book for those who take pleasure in tracing out peculiarities of language. While scholarly, it is not technical, and can be read with enjoyment by an intelligent high school graduate. There is an introduction on the nature of language, chapters on changes of form, change of meaning, change in vocabulary, change in syntax, language and dialect, and the trend of linguistic development.

ROLLA M. TRYON. *Household Manufacturers in the United States, 1640–1860.* Chicago: The University of Chicago Press, 1917. Pp. xii, 413. $2.00.

The sub-title of this valuable book is "A Study in Industrial History." The

author first considers the factors affecting household manufactures in the early days, such as England's colonial policy and the efforts of the colonies to foster industries, then describes the status of household manufacturing in the seventeenth and eighteenth centuries, considers the changes brought by the revolution, gives detailed statistics of a year's output in 1810, and sketches the transition to shop- and factory-made goods. Only the perusal of such a book brings home the vast changes in living which the past century has witnessed.

GEORGE RANSOM TWISS. *A Textbook in the Principles of Science Teaching.* New York: The Macmillan Company, 1917. Pp. xxvi, 486. $1.40.

This splendid survey of the teaching of science calls forth the unqualified approval of the critical student of education. Rarely does one find such grasp, such breadth of view, such sanity and clarity of presentation as is evidenced here. The significance of science in life and in the curriculum is ably set forth; the doctrine of mental discipline is stated with due caution, and with full appreciation of the findings of modern psychology; the suggestions on method are ample without being burdensome; and the bibliographies are exceptionally complete and well chosen. The chief individual sciences considered are biology, geography, physics, and chemistry. There is an edifying chapter on "general science" courses in which the project method is given the preference over the informational method. A final chapter on examinations and tests emphasizes the variability of teachers' marks according to recent studies, and recommends a ranking method rather than the usual percentage method of rating. The book shows a study and appreciation of the results of recent experimental and statistical investigations of education that is to be commended to other writers on secondary education.

THE WORLD BOOK. *Organized Knowledge in Story and Picture.* Edited by M. V. O'Shea, Ellsworth D. Foster, and George H. Locke, assisted by one hundred and fifty distinguished scientists, educators, artists and leaders of thought in the United States and Canada. Chicago: Hanson-Roach-Fowler Company, 1917. Complete in eight volumes. Vol. 3, Crow-Gloucester, pp. 1649–2512. Vol. 4, Glove-Lemay, pp. 2513–3376. Vol. 5, Lemberg-New Year, pp. 3377–4190. Vol. 6, New York-Rice, pp., 4192–5008. Vol. 7, Richard–Tides, pp., 5009–5808. Vol. 8, Tie–Zwingli, pp., 5809–6528.

The present volumes of this magnificent educational compendium bear out the promise of the earlier ones. It is indeed a treat to pick up these sumptuous volumes and explore the riches that lie at hand for both teacher and pupil, young and old. Is the child interested in nature study? Then he will find here three pages on minerals, five pages on fishes, several pages on birds, reptiles, mammals, insects, plant life, and nine pages on nature study itself. If it is some difficulty in fractions that bothers the pupil he will find a clear explanation under that head. In geography, astronomy, history, literature, and science the high school pupil will find easily and quickly just what he most needs. The elementary teacher will be able to use the work to advantage in the preparation of almost every lesson. On topics of current interest, such as the geography of the present war, no reference work can be found which will compare with this in timeliness and completeness. In short, for any educational or informational purpose whatsoever one could scarcely err in recommending this work too highly.